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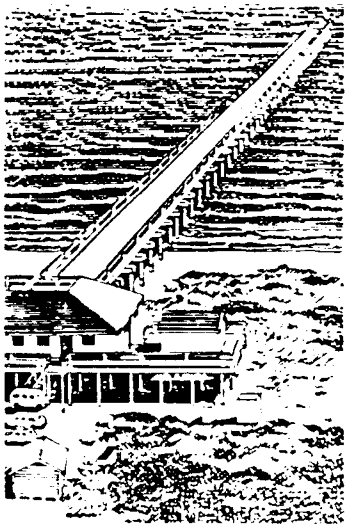

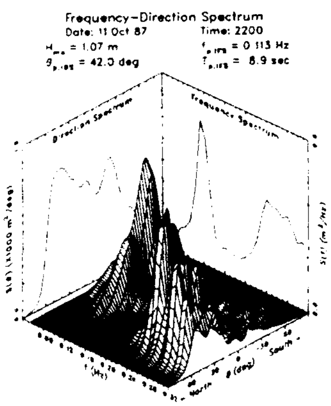

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INDEX AND BULK PARAMETERS FOR FREQUENCY-DIRECTION SPECTRA MEASURED AT CERC FIELD RESEARCH FACILITY, SEPTEMBER 1987 TO AUGUST 1988

by

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The directional distribution of wind-wave energy is an intuitively and demonstrably important aspect of sea state definition in coastal engineering design. Historically, there has been a shortage of high-resolution observations upon which to base engineering guidance. To remedy this, a multiyear series of measurements has been undertaken at the Field Research Facility of the Coastal Engineering Research Center, US Army Engineer Waterways Experiment Station. Cross spectra of surface-corrected signals from a linear array of nine bottom-mounted pressure sensors have been used in conjunction with an iterative maximum likelihood algorithm to estimate frequency-direction spectra. The array was located in about 8 m of water, approximately 900 m offshore.

This report provides an index of and describes a means of access to 636 frequency-direction spectral observations obtained nominally from September 1987 to August 1988. This period represents the second year of data

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collection. Actual data are reported only until early January 1988. Damage to the array by fishing trawlers precluded successful data collection for the remainder of this collection year. In addition to a list of data collection start times are a set of bulk parameters that can be used to characterize the observations. These parameters include characteristic wave height, spectral peak frequency and corresponding peak period, peak wave direction, and directional spread. Time series graphs of these parameters as well as local winds and currents illustrate some of the salient climatology.

Observed spectra have been archived on magnetic tape and can be provided to a user on request. This report describes the structure, format, and naming scheme of the data files and lists a FORTRAN program that can be used to read them.

Preface

This report provides an index of and describes a means of access to a series of wind-wave frequency-direction spectral observations made with a special, high-resolution directional wave gage. The work was motivated by a paucity of observations of directionally distributed wave energy that has hindered understanding and modeling of nearshore processes which affect coastal engineering projects. This effort was authorized by Headquarters, US Army Corps of Engineers (HQUSACE), under Civil Works Research Work Unit 32484, "Directionality of Waves in Shallow Water," Coastal Flooding Program. Funds were provided through the Coastal Engineering Research Center (CERC), US Army Engineer Waterways Experiment Station (WES), under the program management of Dr. C. Linwood Vincent, CERC. Messrs. John H. Lockhart, Jr.; John G. Housley; Robert H. Campbell; and James E. Crews were HQUSACE Technical Monitors.

This data summary was prepared by Dr. Charles E. Long at the WES/CERC Field Research Facility (FRF) in Duck, NC, under the direct supervision of Mr. William A. Birkemeier, Chief, FRF, and Mr. Thomas W. Richardson, Chief, Engineering Development Division, CERC; and under the general supervision of Dr. James R. Houston and Mr. Charles C. Calhoun, Jr., Chief and Assistant Chief, CERC, respectively.

The directional wave gage and its data processing software were designed by Dr. Joan M. Oltman-Shay of Oregon State University through an Intergovernmental Personnel Agreement. This work would not be possible without continued physical maintenance of the directional wave gage. This was done by the FRF dive team consisting of Messrs. Birkemeier, Michael W. Leffler, H. Carl Miller, Eugene W. Bichner, and Brian L. Scarborough. Gage calibration was maintained by Mr. Kent K. Hathaway of the FRF. Acquisition, monitoring, and storage of raw data were done by Mr. Clifford F. Baron of the FRF. This report was edited by Ms. Lee T. Byrne, Information Technology Laboratory, WES.

Commander and Director of WES during the publication of this report was COL Larry B. Fulton, EN. Dr. Robert W. Whalin was Technical Director.

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INDEX AND BULK PARAMETERS FOR FREQUENCY-DIRECTION SPECTRA MEASURED AT CERC FIELD RESEARCH FACILITY, SEPTEMBER 1987 TO AUGUST 1988

Introduction

1. Of importance to an engineer estimating the durability of or designing a modification to a natural boundary is the range and magnitude of forces due to ocean waves in the so-called wind-wave frequency band (roughly 0.04 to 0.3 Hz). Such waves are among the dominant forcing mechanisms in all coastal processes. Estimation of wave forces requires knowledge of the sea state in the region of interest. Description of a sea state requires a minimum of an amplitude, a frequency, and a direction for each component of the wave field. Historically, there have been many observations of wave amplitude and frequency but very few detailed observations of wave direction, due primarily to additional technical requirements in making such measurements. This represents a distinct and very important void in knowledge required for comprehensive engineering design.

2. In September 1986, as a beginning in alleviating this dearth of knowledge, the Field Research Facility (FRF) of the Coastal Engineering Research Center (CERC), US Army Engineer Waterways Experiment Station (WES), installed a high-resolution, linear array directional wave gage for long-term observations of nearshore directional wave climate at its site near Duck, NC (Figure 1). Data thus obtained, which take the form of wave frequency-direction spectra, are intended for use by the broadest possible group of researchers and application engineers, and have been archived in a simple form of data base. This report is intended to simplify dissemination of these data by providing an index of and describing a means of access to the set of observations collected during the first year of deployment.

3. The beginning text of this document is intended to describe and clarify the substantial information contained in the appendices. A brief overview is given of the measurement site, instrumentation, data collection, and method of directional spectral estimation. These subjects are described in other publications to which the reader is referred for greater detail. Following the overview is a description of the archived frequency-direction spectra and some characterizing bulk parameters that can be derived from them.

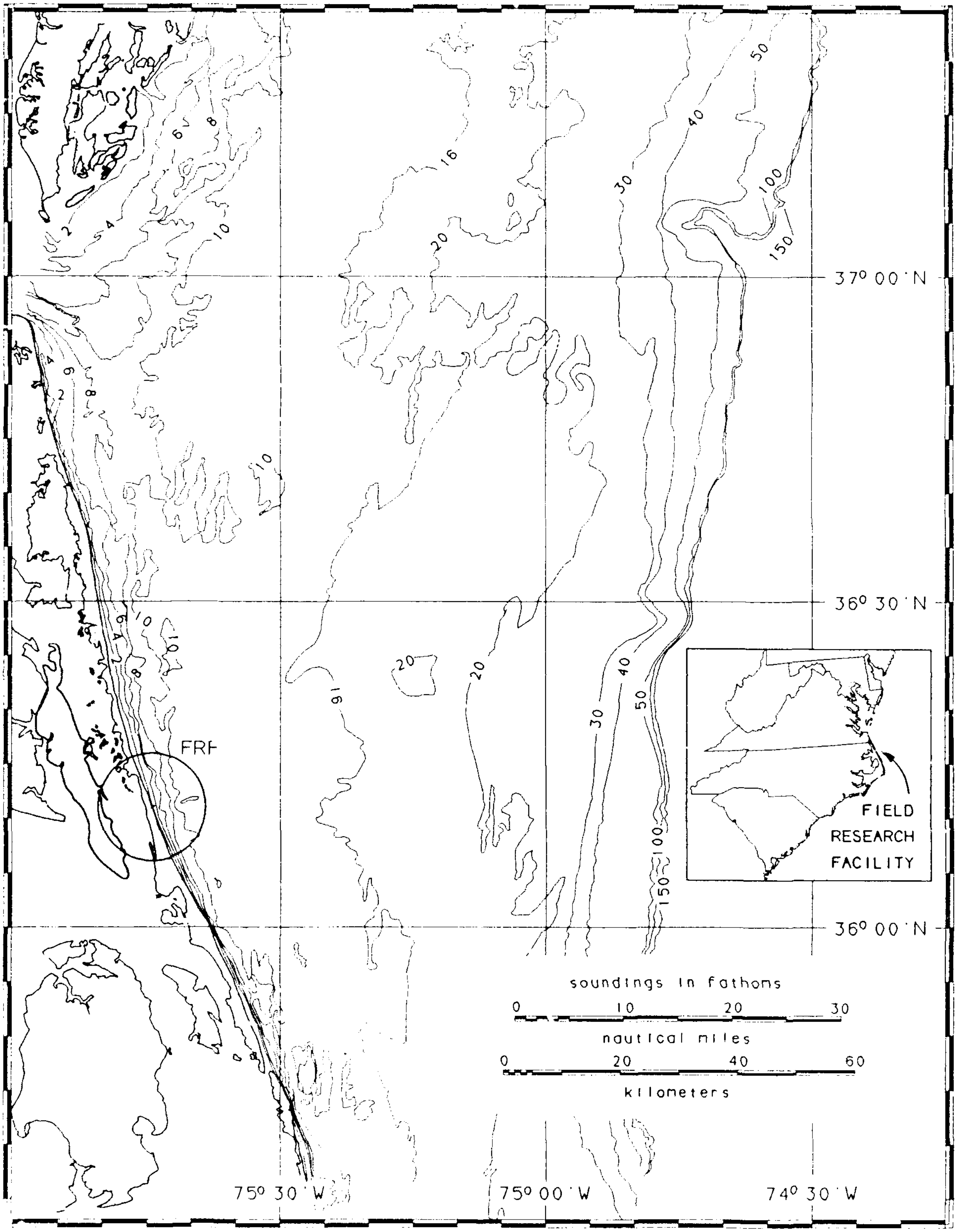


Figure 1. Location and offshore bathymetry of the FRF

Appendix A is a listing of these characterizing parameters and is intended to be used as a kind of catalog of the set of spectra. Appendix B contains graphs of time series of some of these parameters as a pictorial augmentation of the information in Appendix A. Appendix C illustrates a FORTRAN computer program that can be used to read archived data of which a sample listing is given in Appendix D.

Measurement Site

4. As shown in Figure 1, the FRF is located on the barrier island chain of coastal North Carolina. A detailed description of the layout, function, and capabilities of the FRF is given by Birkemeier et al. (1985). Of particular relevance to directional wave studies are the wave-steering bathymetry and wave-generating winds.

5. As regards the former, the coastline in the vicinity of the FRF is nearly straight for several tens of kilometres north and south (Figure 1). It is oriented such that a shore-normal line (directed seaward) is very nearly 70 deg from true north. Waves and onshore winds can approach this site along an easterly 180-deg arc from 340 to 160 deg true. The adjacent continental shelf is wide, relatively shallow, and of somewhat complex bathymetry. The direction of nearest approach of the 100-m isobath, which indicates the shelf break, is 10 to 15 deg south of east and is about 80 km distant. A typical bottom slope for the shelf is 1 m/km, but this is interrupted by numerous features of 1- to 10-km horizontal scales and 10-m vertical scales scattered irregularly across the shelf.

6. Within a few kilometres of the FRF, the offshore bathymetry is more regular, with isobaths nearly shore-parallel and a bottom slope of about 2 m/km (Figure 2). Some irregularities exist. Within about 300 m of the shore, there exists a complex and mobile bar system (Birkemeier 1984). Waves and currents have created some irregular bathymetry in the vicinity of the FRF research pier which extends about 600 m offshore (Miller, Birkemeier, and DeWall 1983).

7. The site is subject to a variety of climates which gives rise to a diverse set of directional wave conditions. Primary sources of high-energy waves are winds associated with hurricanes and frontal passages. Though several hurricanes have passed over or near the FRF since its founding in

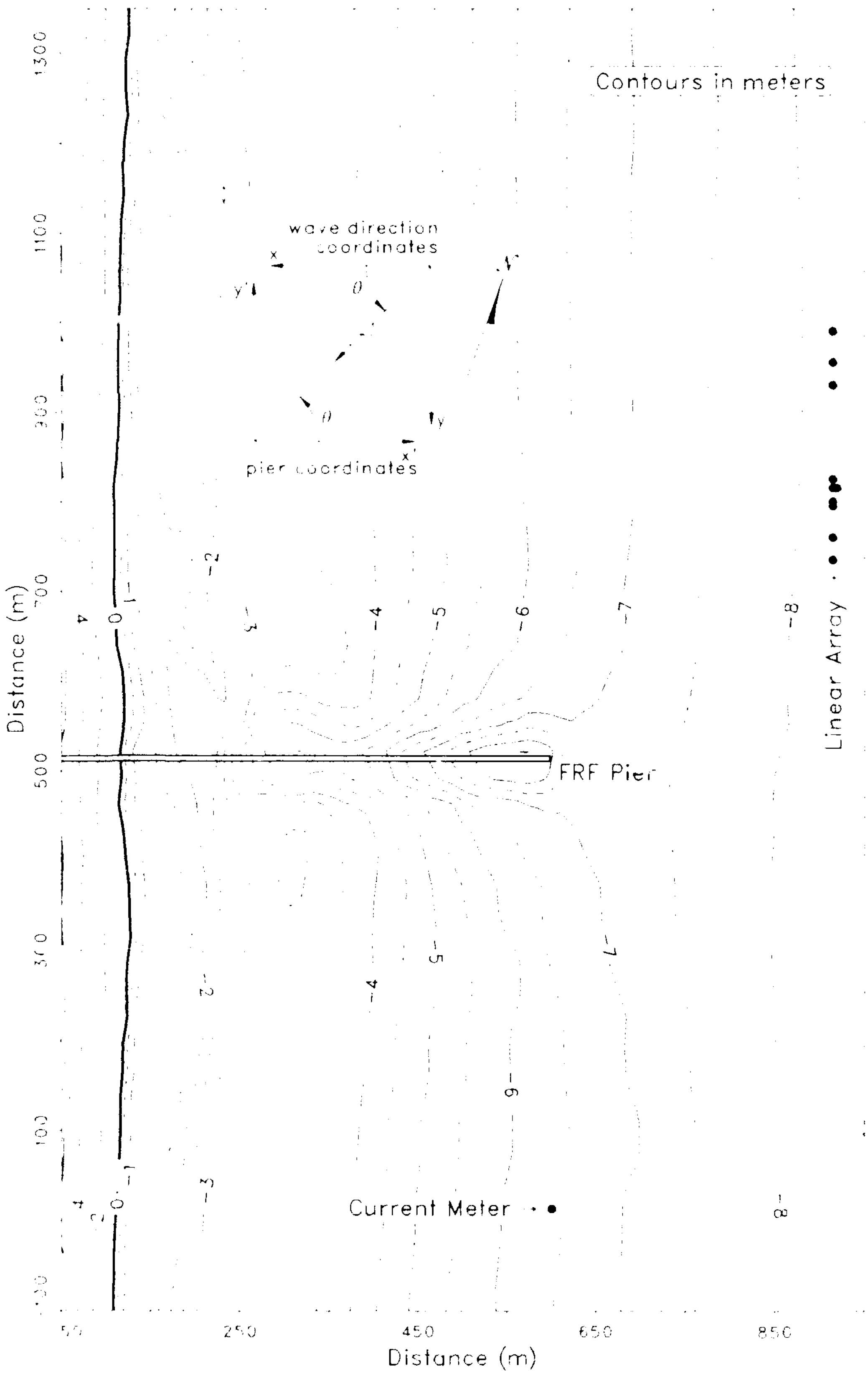


Figure 2. FRF nearshore bathymetry and coordinate system

1979, none did so in the period covered by this report. Low-pressure weather fronts, of which several crossed the FRF site during this reporting year, were typically oriented northeast-southwest, with strong wave-generating winds coming from the northeast. Detailed, quantitative descriptions of the climate at the FRF, as determined from its arsenal of instrumentation, during the period covered by this report are given by Leffler et al. (1989, 1990).

Instrumentation

8. The primary instrument in this study is a high-resolution, linear array directional wave gage. It consists of two parts. The first is an array of sensors that sample sea-surface displacement at several points in (horizontal) space. The second, described in the following section on data processing, is the mathematical treatment of these data to obtain estimates of wave directionality.

9. The FRF array consists of nine pressure gages mounted 0.5 m off the bottom along the 8-m isobath about 900 m offshore and to the north of the research pier (Figure 2). Its location satisfies three constraints. First, it is generally outside the surf zone so that linear wave theory is applicable in data processing. Second, it is in water shallow enough that signals from 3-sec waves, the shortest periods of interest here, are detectable above background noise at the bottom-mounted gages. Third, it is away from the irregular isobaths around the pier and in the nearshore bar system, which helps minimize bathymetrically induced inhomogeneities in the wave field.

10. Spacing between the gages along the linear array appears irregular in Figure 2 but, for the most part, corresponds to the array-design criterion posed by Davis and Regier (1977) that every gage pair have a unique separation. Figure 3 is an enlarged view of the array layout and shows gage spacing as well as the gage numbering scheme. Gage number 10 is not used in linear array analysis but is used in error checking. Minimum gage spacing is 5 m, maximum spacing (the length of the array) is 255 m, and intermediate gage spacings are in multiples of 5 m. With nine gages, there are 36 possible unique spacings. In the FRF array, there are 8 redundant spacings left intentionally for ancillary examination of spatial homogeneity of the wave field. There remain 28 unique spacings.

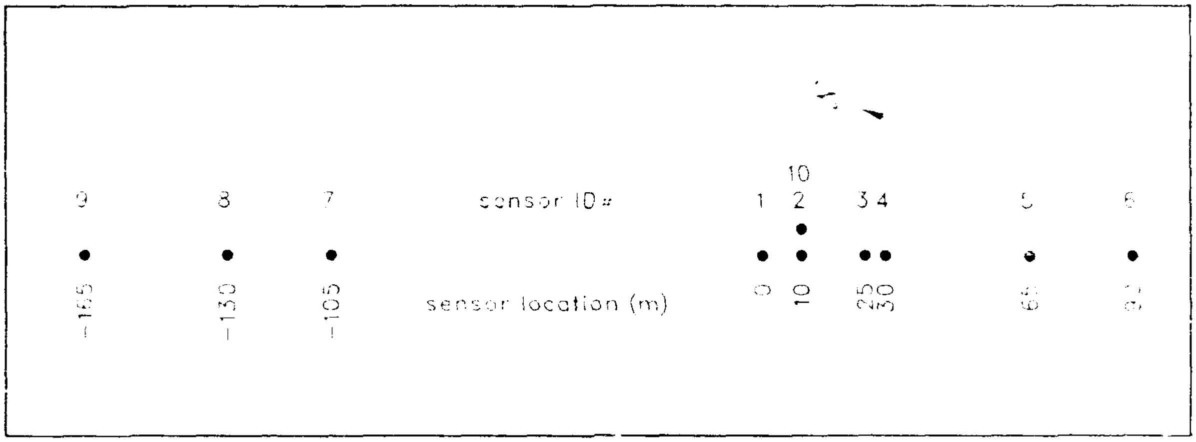


Figure 3. Spacing and numbering of linear array gages

11. Each pressure gage is a Senso-Metric Model SP973(C), in which a piezo-electric strain gage detects displacement of a pressure-sensitive diaphragm referenced to an evacuated cavity. Site calibrations indicate an accuracy of the pressure equivalent of ±0.006 m of water for wave-induced fluctuations about a static water column height of 8 m. Voltage analogs of pressure signals are hard-wired through a 10-Hz, fourth-order, Butterworth filter (primarily to eliminate 60-Hz noise) to an analog-to-digital signal converter and then to a Digital Equipment Corporation VAX 11/750 computer for data acquisition. Discretization of the full-scale signal to 11-bit binary form results in a digitization step of the equivalent of 0.007 m of water, which is nearly the same as gage accuracy.

Data Collection

12. Signals from each of the nine pressure gages were sampled at 2 Hz and stored digitally as records of 4,096 points (34 min 8 sec). A normal collection consisted of four such records or 16,384 points (2 hr 16 min 32 sec) for each gage. Hence, a total of 147,456 data points were collected to produce one frequency-direction spectrum. Starting times for normal collections are the same as those for routine FRF observations (Birkemeier et al. 1985), which occur daily at 0100, 0700, 1300, and 1900 Eastern Standard Time (EST). At times of high energy or when specifically requested by an investigator, additional daily collections occur at 0400, 1000, 1600, and 2200 EST.

13. About half of the second year of linear array data collection followed this schedule. In December 1987, the array suffered considerable damage when one or more fishing trawlers unintentionally dragged nets over the array. Several gages were immediately rendered inoperative, but enough gages continued to function that directional spectral estimates of reduced resolution could still be made. Other gages sustained damage that weakened their integrity. By early January 1988, fewer than four gages remained operational. After this point, no further data were analyzed until the array was repaired. Damage assessment could not take place until the weather was favorable in the spring of 1988. Lead times on repair parts were such that repairs could not be effected until September 1988, which was the beginning of the third year of data collection and hence not included in this report. As a result, the actual period of data coverage during the second year of collection was from September 1987 to January 1988. A total of 636 frequency-direction spectra were obtained. Appendix B contains time-series plots of spectral parameters with winds and currents as auxiliary environmental variables. All available data are plotted for all 12 months to provide as continuous a record as possible, even though directional data are missing from January to August 1988.

14. In regard to protecting the gage, it is noted that careful placement of large, surface-floating buoys along the line of the array has since been found to reduce substantially the threat of trawler damage. With one buoy at the north end of the array, another in the middle of the array, and a third at the south end of the array, the trawlers tend to veer off the line of the array and hence avoid the gages. No notable trawler damage has occurred in the 2 years from the deployment of these "guard" buoys to the drafting of this report.

Data Processing

15. Conversion of measured time series to estimates of frequency-direction spectra requires products of frequency spectral estimates from the nine gages in the array. For final results to be accurate, raw input data must be of exceptionally high quality so that spikey or drifty data from one gage do not contaminate products of results from the other eight gages. Hence, the procedure for data processing is to check the raw data for errors,

estimate the frequency-direction spectrum, and then compute some bulk parameters with which to characterize the result.

Error checking

16. Since multiple gages were deployed in an (assumed) uniform sea, certain statistical properties of raw data from the nine gages should be identical. Hence, properties of data from these gages can be intercompared to isolate bad gages. Two types of properties were used: integral, requiring summing of data, and extremal, derived from maximal and minimal characteristics of a time series. Integral properties used were mean value, standard deviation, skewness, (excess) kurtosis, and trend. Extremal properties were maximum and minimum values, first derivatives, and second derivatives. Reference values were then established for each property. Except for skewness and kurtosis, which have expected values of zero, reference values were the medians of each property determined from the nine gages of the linear array plus the tenth gage shown in Figure 3. If a property of any gage deviated from the reference value by more than a preset, empirically determined amount, it was flagged as being suspect, and the data were then further examined by hand to ensure that the flagging procedure had indeed identified a malfunctioning gage. A more detailed description of the error checking procedure is given by Long and Oltman-Shay (in preparation).

17. If a gage malfunctioned, it was not used in further analysis. The analysis programs were written so that data from a subset of gages could be analyzed. Using fewer gages results in reduced directional resolution, with some gages being more critical than others. If either of the two gages with the smallest spacing is lost, results are invalid at high frequencies due to aliasing. In this case, no analysis was performed. If these two were not lost, a full analysis was done. For the data set described here, there were never fewer than six functioning gages in the linear array. To keep track of the set of functioning gages, a parameter called the gage pattern was created and stored with the results for each collection. The gage pattern is a nine-place character string that represents the linear array gages in order of placement. Each place in the string contains the gage number if the gage was functioning properly or a minus sign (-) if the gage was not used in analysis.

Frequency-direction spectra

18. Estimation of the frequency-direction spectrum is done in four parts. First, time series of pressure data from each gage are Fourier transformed to the frequency domain. Second, these transforms are converted to sea-surface displacement transforms. Third, cross-spectra of sea-surface displacement are computed between all unique gage pairs for each frequency. Finally, an estimate is made of a directional distribution of wave energy that corresponds to the computed spatial variation in cross-spectral density for each frequency.

19. The Fourier transform is conventional. A 16,384-point time series is divided into 15 half-overlapping segments of 2,048 points. Segments are tapered with a Kaiser-Bessel window (a modified Bessel function of the first kind, compensated uniformly for loss of variance due to windowing) and fast Fourier transformed. An intermediate-resolution transform is found by averaging the 15 transformed segments, frequency by frequency. Final transforms are found by then averaging results over 10 adjacent frequency bands. Final resolution bandwidth is 0.00976 Hz, and degrees of freedom are at least 150 (assuming 8 contiguous segments and ignoring any gain from lapped segments). Transform estimates are retained for 28 frequency bands with band-center frequency ranging from 0.054 to 0.318 Hz.

20. Conversion of pressure signals at depth to water-surface displacement is done through the linear wave theory pressure response factor as described in the Shore Protection Manual (SPM) (1984). After this conversion, complex cross-spectra in the form of coincident and quadrature spectra are computed in the conventional way (Bendat and Piersol 1971, Jenkins and Watts 1968) between all unique gage pairs. Cross-spectral estimates at a given frequency are then ordered in terms of gage separation distance, or lag space, in preparation for directional spectral estimation at that frequency.

21. Conversion of cross-spectral patterns in lag space to directional spectra is done with the Iterative Maximum Likelihood Estimation (IMLE) algorithm derived and described by Pawka (1982, 1983). The algorithm is also described in application to data from heave-pitch-roll buoys by Oltman-Shay and Guza (1984). Accuracy of directional estimates depends on frequency, with high-frequency waves (short wavelengths) being better resolved by an array of finite length. Tests with artificial data indicate the FRF array generally can resolve the direction of a unidirectional wave train to within 5 deg and

can distinguish two wave trains at the same frequency if their directions differ by at least 15 deg.

22. The algorithm used here yields discrete direction "bandwidths" or arcs of about 0.5 deg for 0.318-Hz waves to about 3.5 deg for 0.054-Hz waves. It is convenient to have direction increments the same for all frequencies so that a regular array can be used to represent the full frequency-direction spectrum. As a trade-off between the two discrete arc-width extremes, directional results were integrated over 2-deg arcs and renormalized with this arc width to create evenly spaced directional spectra at all frequencies. By nature, linear array results have a 180-deg ambiguity in directional detection. It is assumed here that most wind-wave energy propagates onshore and that an insignificant amount of energy propagates offshore. Directions of interest are then in the 180-deg arc representing seaward approach directions. Dividing this range into 2-deg arcs results in 91 arc center directions with which to characterize discretely the directional distribution of wave energy at a given frequency.

23. The primary result of data processing is an estimate of the discrete frequency-direction spectrum $S(f_n, \theta_m)$, which represents* the variance of sea-surface displacement per frequency resolution bandwidth df (= 0.00976 Hz) per direction resolution arc $d\theta$ (= 2 deg), where f_n is the n^{th} of $N = 28$ discrete frequencies and θ_m is the m^{th} of $M = 91$ discrete directions. In this work, direction is considered to be the angle from which wave energy is coming, measured counterclockwise from shore normal (Figure 3).

24. Numerical values of $S(f_n, \theta_m)$ can range over many orders of magnitude, depending on the amount of energy in a given frequency band and direction arc, and this can require space-consuming formats for archiving data. To simplify this problem, frequency-direction spectra can be saved in the form of directional distribution functions $D(f_n, \theta_m)$ defined by

$$D(f_n, \theta_m) = \frac{S(f_n, \theta_m)}{S(f_n)} \qquad (1)$$

* For convenience, symbols and abbreviations are listed in the Notation (Appendix E).

where $S(f_n)$ is the frequency spectral density at frequency f_n . The directional distribution function has units of deg^{-1}, and its integral with respect to direction over all directions is unity.

25. The frequency spectrum in Equation 1 represents the total over all directions of sea-surface variance per frequency bandwidth and is defined in terms of the frequency-direction spectrum by

$$S(f_n) = \sum_{m=1}^{M} S(f_n, \theta_m)\ d\theta \tag{2}$$

Note that this is the same thing as a conventional frequency spectrum that would result from a time series of sea-surface displacements at a single point in space. Since it is an integral of the frequency-direction spectrum, it is called the integrated frequency spectrum.

26. A directional analog of the frequency spectrum is the integrated direction spectrum, found by summing the frequency-direction spectrum over all frequencies for a fixed direction arc. It is computed from

$$S(\theta_m) = \sum_{n=1}^{N} S(f_n, \theta_m)\ df \tag{3}$$

Figure 4 shows one way to display the frequency-direction spectrum and the corresponding integrated frequency and integrated direction spectra.

<u>Bulk parameters</u>

27. Several parameters have been computed to characterize the observed spectra. There are four basic types of parameter: characteristic wave height, peak frequency (or its inverse, peak period), peak direction, and directional spread. There is more than one way to define some of these parameters, so several alternate forms are presented here.

28. <u>Characteristic wave height.</u> Characteristic wave heights from spectral observations are most frequently given as H_{mo} , which is four times the standard deviation of sea-surface displacement. It can be determined from the volume under the frequency-direction spectrum by the equation

$$H_{mo}^2 = 16 \sum_{n=1}^{N} \sum_{m=1}^{M} S(f_n, \theta_m)\ df\ d\theta \tag{4}$$

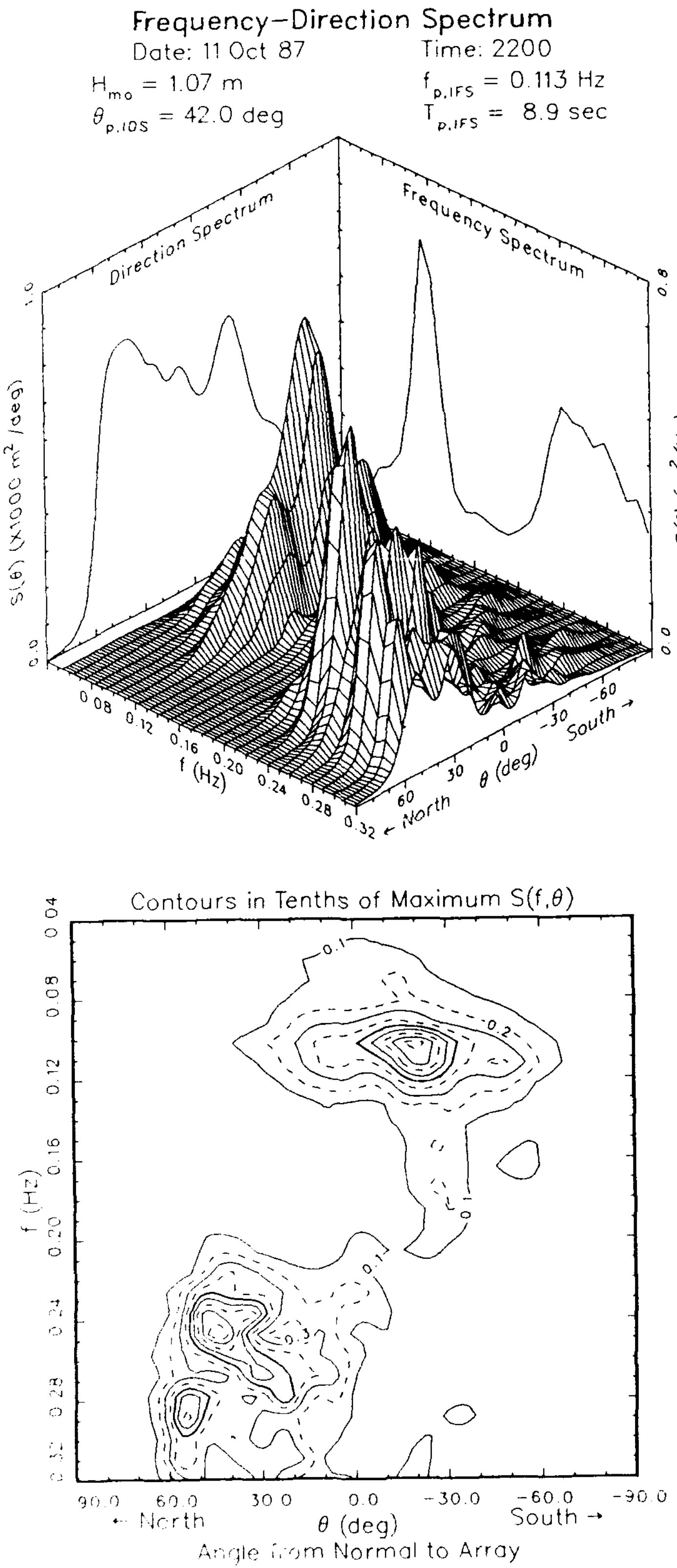


Figure 4. Sample frequency-direction spectrum

It can also be found from the integrated frequency spectrum by

$$H_{mo}^2 = 16 \sum_{n=1}^{N} S(f_n) \; df \tag{5}$$

which is its more conventional definition, or from the integrated direction spectrum by

$$H_{mo}^2 = 16 \sum_{m=1}^{M} S(\theta_m) \; d\theta \tag{6}$$

29. Peak frequency. Peak frequency, which has the generic notation f_p , can be defined at least two ways. One way is to find the frequency (and direction) at which the frequency-direction spectrum is maximum. This peak frequency is denoted $f_{p,FD}$. Another way is to find the frequency at which the integrated frequency spectrum is maximum. This is the more conventional definition, because of the plethora of measured frequency spectra, and it is denoted $f_{p,IFS}$. The two peak frequencies may not be the same. If the directional distribution is broad at the frequency for which the integrated frequency spectrum is maximum, it is possible that another frequency, at which the frequency-direction spectrum has a narrow directional distribution, will denote the maximum of the frequency-direction spectrum.

30. Peak period. Peak period is the characteristic wave period associated with spectral peak frequency. Denoted generically by T_p , it is related to peak frequency by $T_p = 1/f_p$. Peak period from the frequency-direction spectrum is given by $T_{p,FD} = 1/f_{p,FD}$. Conventional peak period, derived from the integrated frequency spectrum, is given by $T_{p,IFS} = 1/f_{p,IFS}$.

31. Peak direction. Peak direction is the direction representing the most energy. Given the generic symbol θ_p , it, too, can be defined in several ways. One peak direction can be defined from the maximum of the frequency-direction spectrum. It is denoted by $\theta_{p,FD}$. Another peak direction can be associated with the maximum of the integrated direction spectrum, defined above. This peak direction is denoted $\theta_{p,IDS}$. It can differ from $\theta_{p,FD}$ if energy in the frequency-direction spectrum is centered at different directions for different frequencies. This condition tends to smear energy

along the direction axis in the integrated direction spectrum, thereby shifting the peak relative to the peak of the frequency-direction spectrum. A third measure of peak direction is a weighted average peak direction defined by

$$\theta_{p,SW} = \frac{1}{(\frac{1}{4}H_{mo})^2} \sum_{n=1}^{N} S(f_n)\ \theta_{p,n} \tag{7}$$

where $\theta_{p,n}$ is peak direction of the directional distribution at the n^{th} frequency of the frequency-direction spectrum, $S(f_n)$ is the integrated frequency spectrum from Equation 2, and H_{mo} is defined by Equation 4. This definition gives higher weights to the more energetic peak directions but does not rely on the single distribution with the most energy.

32. Directional spread. A fourth type of characteristic parameter is directional spread. This parameter, denoted generically as $\Delta\theta$, gives a measure of the range of directions from which some significant fraction of energy is propagating. The basic definition used here is the arc subtended by the middle two quartiles of a directional distribution. As illustrated in Figure 5, the directional distribution function $D(f_n, \theta_m)$ for a particular frequency f_n can be integrated from one bounding direction (here the shore-parallel direction at +90 deg) to some arbitrary direction θ_j to make a kind of cumulative distribution function $I(f_n, \theta_j)$. The formal definition is

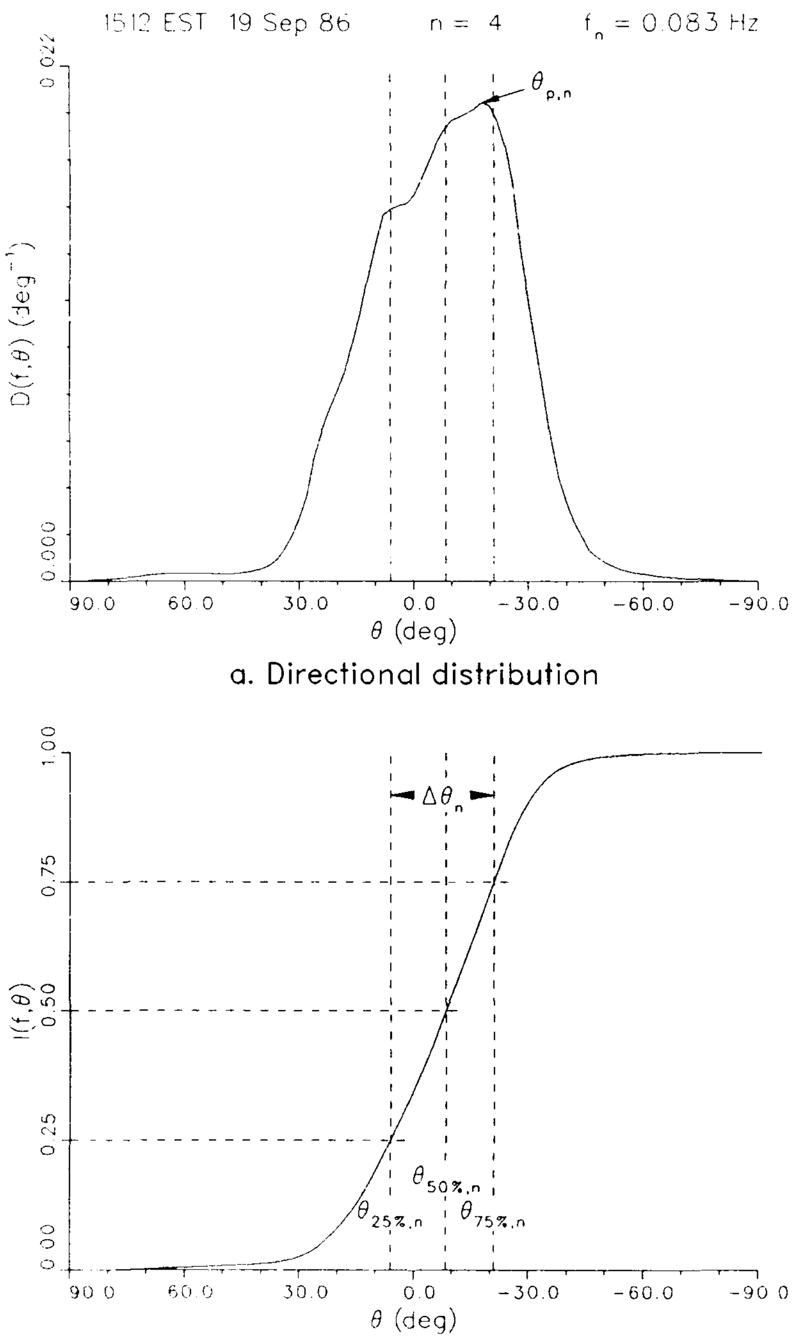
$$I(f_n, \theta_j) = \sum_{m=1}^{j} D(f_n, \theta_m)\ d\theta \tag{8}$$

where j is the index of a discrete angle bin. The three quartile directions, called $\theta_{25\%,n}$, $\theta_{50\%,n}$ and $\theta_{75\%,n}$, respectively, satisfy the equations

$$I(f_n, \theta_{25\%,n}) = 0.25 \tag{9}$$

$$I(f_n, \theta_{50\%,n}) = 0.50 \tag{10}$$

$$I(f_n, \theta_{75\%,n}) = 0.75 \tag{11}$$



a. Directional distribution

b. Cumulative distribution

Figure 5. Directional spread computation

A directional spread parameter for the n^{th} frequency is defined by the expression

$$\Delta\theta_n = \theta_{25\%,n} - \theta_{75\%,n} \tag{12}$$

33. If Equation 12 is applied at the frequency where the frequency-direction spectrum is maximum, a measure of directional spread at the peak of the frequency-direction spectrum is obtained. This parameter is denoted $\Delta\theta_{FDP}$. If, instead of a directional distribution function at a single frequency, the normalized integrated direction spectrum is used in the set of Equations 8 to 12 , a measure of bulk directional spread is obtained. This parameter is given the symbol $\Delta\theta_{IDS}$. A third measure of directional spread is found from a spectrally weighted average of the spreads at each frequency. Denoted as $\Delta\theta_{SW}$, this parameter is found from

$$\Delta\theta_{SW} = \frac{1}{(\frac{1}{4}H_{mo})^2} \sum_{n=1}^{N} S(f_n)\ \Delta\theta_n \tag{13}$$

Equation 13 is like Equation 7 for the spectrally weighted peak direction.

34. Together, these 11 parameters give a bulk characterization of some properties of a frequency-direction spectrum. There are, of course, many other parameters that can be defined, but the present set is simple and is rather easier to use than the 2,548 discrete spectral densities (28 frequencies times 91 directions) required for a full description of the spectra discussed here.

Archived Results

35. A magnetic tape containing the set of observed frequency-direction spectra from the first year of collection has been prepared for copying and distribution (upon request). Appendix A contains a listing of the date, starting time, and the characterizing parameters defined previously for each case. It is intended to be used as a kind of index or catalog of the set of available cases. For reasons explained below, dates are given in the form yymmdd where yy is a two-digit year indicator (e.g., 87 means 1987), mm is the numeric index of the calender month (i.e, 01 is January, 12 is

December, etc.), and dd is day of the month. All times are Eastern Standard Time. A 24-hr clock is used.

36. A graphic representation of data collection times, some bulk parameters, and some auxiliary environmental variables is contained in Appendix B. One graph is shown for each month of the collection year. The upper part of each graph has time series plots of the bulk parameters H_{mo}, $T_{p,IFS}$, $\theta_{p,IDS}$, and $\Delta\theta_{IDS}$. The lower part of each graph has stick figure plots of three environmental variables. First is a kind of crude wave vector in which the stick vector has a length proportional to H_{mo} and a direction given by $\theta_{p,IDS} + 180$ deg. The 180 deg is added to provide a physical frame of reference consistent with a vector pointing in the direction of energy propagation. The assumption that all waves propagate onshore means that all stick vectors in this part of the graph will have a component directed upward on the page.

37. The second stick figure plot is the wind vector as measured with the FRF environmental anemometer. Mounted atop the FRF laboratory building at an elevation of 19.5 m above mean sea level, this instrument gives a reasonable estimate of the wind climate in the vicinity of the linear array. The third stick figure plot is the current vector as measured with a current meter located offshore about even with the end of the pier and alongshore about 500 m south of the pier (Figure 2). This instrument was approximately 1.5 m off the bottom in water of about 6-m depth and therefore sensed currents near the bottom. The reader may note a significant anticorrelation between cross-shore winds and cross-shore currents. This is consistent with the behavior of wall-bounded, shallow-water, wind-generated currents. Additional details about the anemometer and current meter are given by Birkemeier et al. (1985).

Retrieving Processed Data

38. The magnetic medium containing directional-spectral data is a 9-track, ASCII-formatted tape written at 6,250 bytes/in. with a 2,048 byte blocksize. This is a rather standard set of tape format parameters, which should make copies of this tape fairly transportable. It may be possible to write the data in other formats, and specific requests can be coordinated with the FRF.

39. The tape contains 636 files, one for each observed frequency-direction spectrum. Each file has a length of about 30,000 bytes, so the complete tape contains roughly 19.1 megabytes of information. A user may wish to consider if space is available on the user's system for this much information before trying to copy the whole tape. It should be possible, however, to read the tape one file at a time. Each file has the generic name FDyymmddhhmm.DAT where FD stands for frequency-direction spectrum, the character grouping yymmdd represents the data collection date (as listed in Appendix A), and the character grouping hhmm represents the data collection start time (also from Appendix A).

40. Once a file is on equipment and in a position to be read, it can be input to a computer program through any ASCII formatted read statement. Appendix C contains a listing of a FORTRAN program that can read the data files. The variables contained in a data file are listed in the header of the program in Appendix C. A listing of a sample data file is given in Appendix D. The read statements in the program in Appendix C can be visually aligned with the data fields of the listing in Appendix D if the user wishes to edit or visually read a data file. Program variable names, especially those that have parallel symbols in this text, are also listed in the Notation (Appendix E).

41. It is intended that the magnetic tape will be maintained for its approximate life of 3 years from the publication date of this report. By that time the data will have been archived in more permanent, and likely different, form. Until then, a user can obtain a copy of the data tape by directing a request to:

Chief, Field Research Facility
1261 Duck Road
Kitty Hawk, NC 27949-4471
Phone: (919) 261-3511
Fax: (919) 261-4432

Summary

42. Data from the second collection year of high-resolution, directional-spectral observations at the FRF have been put in a form that is highly accessible to researchers interested in nearshore processes.

Directional gage, directional analysis algorithms, and definitions of characterizing parameters are described in the body of this report, as are the location and form of archived data. Both a listing and a graphic presentation of data collection times and characteristic parameters are given in the appendices. The appendices also contain a sample data file and a listing of a FORTRAN program that can be used to read a data file.

References

Bendat, J. S., and Piersol, A. G. 1971. Random Data: Analysis and Measurement Procedures, Wiley-Interscience, New York.

Birkemeier, W. A. 1984. "Time Scales of Nearshore Profile Changes," Proceedings of the 19th Coastal Engineering Conference, American Society of Civil Engineers, 3-7 September 1984, Houston, TX, pp 1507-1521.

Birkemeier, W. A., Miller, H. C., Wilhelm, S. D., DeWall, A. E., and Gorbics, C. S. 1985. "A User's Guide to the Coastal Engineering Research Center's (CERC's) Field Research Facility," Technical Report CERC-85-1, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Davis, R. E., and Regier, L. A. 1977. "Methods for Estimating Directional Wave Spectra from Multi-Element Arrays," Journal of Marine Research, Vol 35, pp 453-477.

Jenkins, G. M., and Watts, D. G. 1968. Spectral Analysis and Its Applications, Holden-Day, Oakland, CA.

Leffler, M. W., Hathaway, K. K., Scarborough, B. L., Baron, C. F., and Miller, H. C. 1989. "Annual Data Summary for 1987, CERC Field Research Facility," Technical Report CERC-89-10, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

__________. 1990. "Annual Data Summary for 1988, CERC Field Research Facility," Technical Report CERC-90-13, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Long, C. E., and Oltman-Shay, J. M. "Directional Characteristics of Waves in Shallow Water," Technical Report in preparation, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Miller, H. C., Birkemeier, W. A., and DeWall, A. E. 1983. "Effects of CERC Research Pier on Nearshore Processes," Proceedings of Coastal Structures '83, American Society of Civil Engineers, March 9-11, 1983, Arlington, VA, pp 769-784.

Oltman-Shay, J., and Guza, R. T. 1984. "A Data-Adaptive Ocean Wave Directional-Spectrum Estimator for Pitch and Roll Type Measurements," Journal of Physical Oceanography, Vol 14, pp 1800-1810.

Pawka, S. S. 1982. "Wave Directional Characteristics on a Partially Sheltered Coast," Ph.D. Dissertation, Scripps Institute of Oceanography, University of California, San Diego, CA.

__________. 1983. "Island Shadows in Wave Directional Spectra," Journal of Geophysical Research, Vol 88, pp 2579-2591.

Shore Protection Manual. 1984. 4th Edition, 2 Vols, US Army Engineer Waterways Experiment Station, Coastal Engineering Research Center, US Government Printing Office, Washington, DC.

Appendix A: Table of Collection Times and Bulk Parameters

Bulk Parameters of Observed Frequency-Direction Spectra*

Date	Time EST	H_{mo} m	Peak Frequency $f_{p,FD}$ Hz	Peak Frequency $f_{p,IFS}$ Hz	Peak Period $T_{p,FD}$ sec	Peak Period $T_{p,IFS}$ sec	Peak Direction $\theta_{p,FD}$ deg	Peak Direction $\theta_{p,IDS}$ deg	Peak Direction $\theta_{p,SW}$ deg	Directional Spread $\Delta\theta_{IDS}$ deg	Directional Spread $\Delta\theta_{SW}$ deg	Directional Spread $\Delta\theta_{FDP}$ deg
870901	0100	0.54	0.123	0.123	8.16	8.16	8.0	-28.0	-10.9	45.8	37.8	36.9
870901	0700	0.46	0.142	0.132	7.04	7.56	0.0	0.0	-10.4	41.0	36.4	37.7
870901	1300	0.79	0.230	0.220	4.35	4.54	50.0	50.0	36.3	51.4	38.6	24.2
870901	1900	0.60	0.210	0.113	4.75	8.87	38.0	6.0	24.1	50.0	42.3	35.1
870902	0100	0.53	0.210	0.123	4.75	8.16	32.0	8.0	4.8	47.1	43.3	39.1
870902	0700	0.52	0.113	0.113	8.87	8.87	-10.0	2.0	-0.3	38.2	36.0	31.3
870902	1300	0.48	0.113	0.103	8.87	9.71	4.0	-2.0	-18.3	45.7	41.5	34.2
870902	1900	0.45	0.181	0.181	5.52	5.52	-26.0	-24.0	-22.6	46.2	37.2	34.5
870903	0100	0.58	0.181	0.181	5.52	5.52	-28.0	-26.0	-22.8	33.3	31.6	26.4
870903	0700	0.48	0.181	0.171	5.52	5.83	-20.0	-18.0	-15.6	28.7	29.1	24.6
870903	1300	0.52	0.318	0.318	3.15	3.15	32.0	-30.0	-15.0	39.3	38.9	62.4
870903	1900	0.83	0.250	0.279	4.01	3.59	-30.0	-14.0	8.9	48.0	41.0	43.0
870904	0100	1.41	0.181	0.191	5.52	5.24	-8.0	-10.0	-5.8	42.2	42.0	37.4
870904	0700	1.93	0.171	0.162	5.83	6.19	-2.0	-6.0	-2.0	37.4	38.0	30.8
870904	1300	1.83	0.162	0.152	6.19	6.58	-8.0	-8.0	-0.7	41.3	41.5	41.0
870904	1900	2.03	0.152	0.152	6.58	6.58	18.0	-6.0	2.3	39.1	38.0	35.2
870905	0100	2.06	0.132	0.132	7.56	7.56	-8.0	-2.0	-4.5	39.9	40.0	39.0
870905	0700	1.84	0.132	0.132	7.56	7.56	6.0	-12.0	-5.9	41.0	40.0	39.2
870905	1300	1.89	0.123	0.123	8.16	8.16	0.0	-12.0	-12.1	39.5	38.3	37.0
870905	1900	1.53	0.123	0.123	8.16	8.16	-6.0	-10.0	-10.8	40.1	39.1	35.7
870906	0100	1.46	0.142	0.142	7.04	7.04	-4.0	-8.0	-11.2	38.6	38.3	37.4
870906	0700	1.35	0.113	0.113	8.87	8.87	-14.0	-12.0	-11.3	38.1	38.2	36.6
870906	1300	1.49	0.093	0.083	10.72	11.98	-14.0	-12.0	-14.4	33.8	33.5	31.6
870906	1900	1.34	0.093	0.083	10.72	11.98	-18.0	-20.0	-17.8	36.1	35.6	32.0
870907	0100	1.24	0.103	0.093	9.71	10.72	-10.0	-16.0	-14.0	33.1	33.0	27.9
870907	0700	1.16	0.113	0.103	8.87	9.71	-8.0	-10.0	-11.8	34.4	33.9	28.8
870907	1300	1.13	0.103	0.103	9.71	9.71	-8.0	-14.0	-13.0	33.7	32.3	32.4
870908	0100	1.15	0.142	0.142	7.04	7.04	-12.0	-18.0	-17.1	33.5	32.3	31.3
870908	0700	1.13	0.123	0.113	8.16	8.87	-16.0	-20.0	-23.1	41.0	33.4	30.5
870908	1300	1.04	0.132	0.132	7.56	7.56	2.0	-22.0	-16.0	38.0	33.7	36.6
870908	1900	0.88	0.142	0.123	7.04	8.16	-22.0	-20.0	-16.4	39.7	34.8	33.7
870909	0100	0.72	0.074	0.132	13.57	7.56	0.0	-6.0	-10.7	36.3	33.4	28.6
870909	0700	0.68	0.074	0.074	13.57	13.57	-6.0	-16.0	-17.8	38.2	33.6	31.5
870909	1300	0.55	0.064	0.074	15.62	13.57	-14.0	-12.0	-15.3	34.7	33.5	28.0
870909	1900	0.58	0.064	0.074	15.62	13.57	-10.0	-16.0	-19.6	35.4	34.6	25.8
870910	0100	0.56	0.074	0.074	13.57	13.57	-4.0	-12.0	-16.9	34.5	33.5	29.1
870910	0700	0.58	0.074	0.074	13.57	13.57	-10.0	-10.0	-14.8	37.4	35.3	35.4
870910	1300	0.53	0.074	0.074	13.57	13.57	0.0	-20.0	-10.4	36.9	35.5	33.6
870910	1900	0.59	0.142	0.142	7.04	7.04	-14.0	-20.0	-14.3	33.1	32.2	33.1
870911	0700	0.50	0.142	0.074	7.04	13.57	-4.0	-6.0	-11.1	35.4	35.1	37.4
870911	1900	0.51	0.142	0.074	7.04	13.57	-24.0	-26.0	-6.0	43.0	31.0	25.3
870912	0100	0.50	0.152	0.152	6.58	6.58	-26.0	-26.0	-10.8	43.4	32.3	34.2
870912	0700	0.56	0.220	0.152	4.54	6.58	22.0	22.0	-4.0	46.1	37.7	45.1
870912	1900	0.69	0.162	0.162	6.19	6.19	16.0	6.0	2.0	39.4	37.4	42.1
870913	0100	0.68	0.113	0.113	8.87	8.87	2.0	16.0	10.0	38.4	37.6	33.0
870913	0700	0.88	0.093	0.093	10.72	10.72	4.0	8.0	5.0	37.3	37.5	31.5
870913	1300	0.98	0.093	0.093	10.72	10.72	0.0	4.0	1.2	40.1	38.0	38.5
870913	1900	1.00	0.083	0.083	11.98	11.98	-12.0	-8.0	-6.5	37.0	37.1	34.8
870914	0100	0.89	0.083	0.083	11.98	11.98	2.0	0.0	1.6	37.9	37.2	34.0
870914	1300	0.80	0.093	0.093	10.72	10.72	-2.0	6.0	9.3	42.6	40.2	35.6
870915	0100	0.73	0.103	0.103	9.71	9.71	-4.0	18.0	8.7	39.6	36.2	37.7
870915	1000	0.61	0.103	0.103	9.71	9.71	-4.0	-6.0	1.2	37.4	37.4	35.4
870915	1300	0.63	0.103	0.103	9.71	9.71	-6.0	-8.0	-3.0	36.8	36.1	35.2
870915	1600	0.62	0.103	0.103	9.71	9.71	-6.0	-8.0	-6.3	35.3	35.5	30.2
870915	1900	0.61	0.103	0.103	9.71	9.71	-8.0	-6.0	-9.8	37.4	35.4	34.5

(Continued)

* See Notation (Appendix E) for definitions of terms.

			Peak Frequency		Peak Period		Peak Direction			Directional Spread		
Date	Time EST	H_{mo} m	$f_{p,FD}$ Hz	$f_{p,IFS}$ Hz	$T_{p,FD}$ sec	$T_{p,IFS}$ sec	$\theta_{p,FD}$ deg	$\theta_{p,IDS}$ deg	$\theta_{p,SW}$ deg	$\Delta\theta_{IDS}$ deg	$\Delta\theta_{SW}$ deg	$\Delta\theta_{FDP}$ deg
870915	2200	0.59	0.103	0.103	9.71	9.71	-8.0	-12.0	-13.7	37.1	34.3	33.1
870916	0100	0.55	0.113	0.103	8.87	9.71	-10.0	-10.0	-16.9	38.8	35.4	34.4
870916	0400	0.51	0.103	0.103	9.71	9.71	8.0	-10.0	-11.8	38.4	34.7	33.0
870916	0700	0.49	0.103	0.103	9.71	9.71	-4.0	-4.0	-11.6	39.1	35.7	35.5
870916	1000	0.48	0.103	0.103	9.71	9.71	10.0	-4.0	-10.7	39.7	35.0	37.1
870916	1300	0.48	0.103	0.103	9.71	9.71	-2.0	-16.0	-11.4	40.3	34.9	38.6
870916	1900	0.46	0.103	0.103	9.71	9.71	-8.0	-22.0	-19.0	40.8	35.2	35.3
870916	2200	0.44	0.113	0.113	8.87	8.87	-6.0	-16.0	-15.3	39.1	33.6	29.9
870917	0100	0.42	0.113	0.113	8.87	8.87	-8.0	-6.0	-10.1	42.7	38.0	38.6
870917	0400	0.43	0.113	0.113	8.87	8.87	-10.0	-8.0	-12.0	38.0	35.6	33.6
870917	0700	0.43	0.123	0.103	8.16	9.71	-12.0	-6.0	-5.4	38.0	34.6	32.8
870917	1000	0.44	0.123	0.123	8.16	8.16	-4.0	-8.0	-11.1	38.6	35.0	34.3
870917	1600	0.46	0.074	0.074	13.57	13.57	-4.0	-18.0	-22.5	39.3	28.1	23.4
870917	1900	0.43	0.074	0.074	13.57	13.57	-2.0	-22.0	-21.0	37.3	29.0	26.4
870917	2200	0.43	0.074	0.074	13.57	13.57	-4.0	-10.0	-24.3	43.1	36.0	33.9
870918	0100	0.45	0.074	0.074	13.57	13.57	-6.0	-22.0	-25.7	40.1	35.3	32.5
870918	0400	0.43	0.083	0.083	11.98	11.98	-38.0	-16.0	-25.7	42.8	38.7	41.6
870918	0700	0.44	0.083	0.083	11.98	11.98	-26.0	-22.0	-22.6	36.1	33.4	34.3
870918	1900	0.56	0.103	0.103	9.71	9.71	-20.0	-20.0	-21.1	40.9	37.6	39.0
870918	2200	0.54	0.103	0.103	9.71	9.71	-22.0	-22.0	-20.7	34.5	32.4	30.8
870919	0100	0.53	0.103	0.103	9.71	9.71	-18.0	-22.0	-18.7	34.3	33.9	33.0
870919	0400	0.55	0.103	0.103	9.71	9.71	-22.0	-22.0	-16.6	35.7	35.5	32.3
870919	0700	0.58	0.103	0.103	9.71	9.71	-16.0	-16.0	-12.7	41.6	40.5	39.3
870919	1000	0.66	0.113	0.113	8.87	8.87	-20.0	-20.0	1.7	52.5	42.7	45.2
870919	1300	0.71	0.113	0.113	8.87	8.87	-18.0	22.0	16.7	52.9	43.8	45.5
870919	1600	0.84	0.123	0.123	8.16	8.16	16.0	30.0	22.7	50.4	39.1	44.3
870919	1900	1.03	0.298	0.123	3.35	8.16	22.0	30.0	22.9	38.3	33.8	29.8
870919	2200	1.15	0.123	0.123	8.16	8.16	10.0	12.0	17.0	36.2	33.8	43.0
870920	0100	1.29	0.123	0.123	8.16	8.16	12.0	10.0	15.2	37.4	36.5	43.2
870920	0400	1.27	0.113	0.113	8.87	8.87	4.0	10.0	13.6	39.0	37.1	40.5
870920	0700	1.17	0.113	0.113	8.87	8.87	8.0	26.0	14.0	45.0	42.2	47.3
870920	1000	1.16	0.113	0.113	8.87	8.87	18.0	26.0	15.5	42.3	41.3	34.2
870920	1300	1.22	0.123	0.123	8.16	8.16	6.0	26.0	13.6	45.2	44.3	43.1
870920	1600	1.34	0.210	0.123	4.75	8.16	32.0	30.0	16.2	42.0	39.5	49.5
870920	1900	1.36	0.220	0.113	4.54	8.87	30.0	22.0	6.2	38.2	37.1	34.1
870920	2200	1.34	0.123	0.123	8.16	8.16	10.0	8.0	11.7	38.8	37.3	38.4
870921	0100	1.13	0.123	0.123	8.16	8.16	16.0	18.0	7.0	39.8	33.8	38.5
870921	0400	1.09	0.123	0.123	8.16	8.16	-2.0	-4.0	7.7	41.2	40.4	39.4
870921	0700	1.03	0.123	0.123	8.16	8.16	8.0	12.0	8.6	39.1	38.2	32.4
870921	1000	0.98	0.103	0.103	9.71	9.71	-2.0	12.0	8.6	36.2	36.0	38.8
870921	1300	1.00	0.113	0.103	8.87	9.71	8.0	6.0	6.3	36.2	36.5	35.4
870921	1600	0.91	0.103	0.103	9.71	9.71	-4.0	-2.0	5.3	37.2	37.5	38.6
870921	1900	0.86	0.103	0.103	9.71	9.71	2.0	8.0	4.9	36.9	36.6	36.2
870921	2200	0.81	0.103	0.103	9.71	9.71	6.0	4.0	5.8	35.1	34.9	32.1
870922	0100	0.81	0.103	0.103	9.71	9.71	2.0	4.0	5.2	37.2	37.3	39.1
870922	0400	0.80	0.103	0.113	9.71	8.87	-10.0	-6.0	3.6	35.3	35.5	32.1
870922	0700	0.73	0.103	0.103	9.71	9.71	0.0	6.0	4.2	37.1	37.1	35.5
870922	1000	0.68	0.103	0.103	9.71	9.71	4.0	0.0	4.7	36.5	36.8	39.9
870922	1300	0.70	0.113	0.103	8.87	9.71	-6.0	8.0	0.0	37.5	36.9	32.1
870922	1600	0.69	0.103	0.103	9.71	9.71	14.0	4.0	-0.7	42.0	40.2	38.5
870922	1900	0.62	0.103	0.103	9.71	9.71	-2.0	-2.0	-5.7	41.6	41.6	41.8
870922	2200	0.64	0.093	0.103	10.72	9.71	2.0	0.0	10.9	44.0	36.8	36.4
870923	0100	0.58	0.103	0.103	9.71	9.71	2.0	4.0	8.6	38.3	36.2	35.6
870923	0400	0.56	0.318	0.103	3.15	9.71	54.0	12.0	18.7	47.0	35.7	43.2
870923	0700	0.71	0.230	0.103	4.35	9.71	46.0	50.0	28.9	50.8	25.5	13.0
870923	1000	0.78	0.210	0.113	4.75	8.87	40.0	40.0	30.8	42.0	24.0	15.7
870923	1300	0.65	0.220	0.113	4.54	8.87	40.0	36.0	26.3	43.9	26.5	12.7
870923	1600	0.60	0.220	0.113	4.54	8.87	40.0	40.0	24.4	46.6	27.9	15.0
870923	1900	0.50	0.103	0.113	9.71	8.87	12.0	12.0	21.3	45.7	33.8	29.7
870923	2200	0.47	0.113	0.113	8.87	8.87	16.0	38.0	20.4	48.7	33.2	39.4
870924	0100	0.42	0.113	0.113	8.87	8.87	16.0	-2.0	11.9	37.8	30.0	32.1

(Continued)

(Sheet 2 of 11)

Date	Time	H_{mo}	Peak Frequency		Peak Period		Peak Direction			Directional Spread		
	EST	m	$f_{p,FD}$ Hz	$f_{p,IFS}$ Hz	$T_{p,FD}$ sec	$T_{p,IFS}$ sec	$\theta_{p,FD}$ deg	$\theta_{p,IDS}$ deg	$\theta_{p,SW}$ deg	$\Delta\theta_{IDS}$ deg	$\Delta\theta_{SW}$ deg	$\Delta\theta_{FDP}$ deg
870924	0400	0.40	0.113	0.113	8.87	8.87	14.0	-6.0	8.4	38.1	36.7	37.9
870924	0700	0.39	0.123	0.123	8.16	8.16	8.0	-4.0	3.9	36.3	36.5	35.2
870924	1000	0.36	0.093	0.093	10.72	10.72	-2.0	-4.0	-1.4	37.9	37.0	37.1
870924	1300	0.36	0.103	0.103	9.71	9.71	0.0	-2.0	1.0	35.4	35.1	33.4
870924	1600	0.36	0.103	0.103	9.71	9.71	0.0	-12.0	-2.8	35.6	34.9	32.7
870924	1900	0.38	0.074	0.103	13.57	9.71	-2.0	-4.0	1.3	34.6	34.9	29.1
870924	2200	0.38	0.074	0.074	13.57	13.57	-4.0	-4.0	-3.3	37.5	36.7	33.8
870925	0100	0.35	0.074	0.074	13.57	13.57	-2.0	-4.0	-1.7	36.3	35.4	32.4
870925	0400	0.36	0.074	0.074	13.57	13.57	0.0	0.0	-2.6	35.6	34.9	26.6
870925	0700	0.38	0.103	0.074	9.71	13.57	2.0	0.0	0.1	36.9	38.4	34.9
870925	1300	0.74	0.279	0.279	3.59	3.59	54.0	52.0	38.2	41.8	28.3	21.5
870925	1600	0.82	0.240	0.230	4.17	4.35	18.0	22.0	29.4	37.0	32.9	29.8
870925	1900	0.85	0.201	0.201	4.98	4.98	22.0	22.0	24.0	38.6	33.3	25.6
870925	2200	0.79	0.074	0.074	13.57	13.57	-24.0	20.0	11.3	41.2	32.1	40.6
870926	0100	0.72	0.083	0.083	11.98	11.98	-24.0	16.0	11.0	45.3	33.2	39.0
870926	0400	0.70	0.093	0.074	10.72	13.57	-28.0	14.0	4.3	45.1	34.7	40.9
870926	0700	0.71	0.093	0.074	10.72	13.57	-24.0	10.0	-4.7	43.7	35.7	39.2
870926	1000	0.73	0.083	0.083	11.98	11.98	-20.0	-18.0	-6.1	42.4	34.8	34.4
870926	1300	0.73	0.093	0.083	10.72	11.98	-14.0	-16.0	-0.7	39.1	35.9	32.0
870926	1600	0.66	0.093	0.093	10.72	10.72	-12.0	-12.0	-9.0	42.1	40.4	39.9
870926	1900	0.65	0.093	0.103	10.72	9.71	-8.0	-10.0	-9.6	41.8	39.1	36.1
870926	2200	0.59	0.103	0.103	9.71	9.71	-10.0	-14.0	-14.6	40.8	38.3	37.3
870927	0100	0.54	0.103	0.103	9.71	9.71	-8.0	-16.0	-14.7	33.7	34.0	29.4
870927	0400	0.54	0.113	0.113	8.87	8.87	-10.0	-12.0	-11.2	30.4	30.8	28.1
870927	0700	0.51	0.113	0.113	8.87	8.87	-14.0	-16.0	-12.5	32.8	32.2	30.6
870927	1000	0.46	0.113	0.113	8.87	8.87	-18.0	-22.0	-16.2	34.5	33.1	29.3
870927	1300	0.42	0.123	0.123	8.16	8.16	-16.0	-18.0	-15.5	32.4	31.0	26.4
870927	1600	0.41	0.123	0.123	8.16	8.16	-18.0	-20.0	-16.3	32.3	30.4	28.5
870927	1900	0.41	0.123	0.083	8.16	11.98	-20.0	-20.0	-19.2	33.7	31.2	26.3
870927	2200	0.41	0.132	0.123	7.56	8.16	-24.0	-24.0	-15.7	35.6	32.4	23.3
870928	0100	0.40	0.132	0.132	7.56	7.56	-22.0	-22.0	-19.0	34.1	32.4	25.3
870928	0400	0.40	0.132	0.142	7.56	7.04	-18.0	-16.0	-20.4	34.6	33.1	27.5
870928	1000	0.42	0.318	0.083	3.15	11.98	-62.0	-24.0	-24.6	41.8	36.6	62.9
870928	1300	0.39	0.132	0.083	7.56	11.98	-18.0	-20.0	-24.4	33.5	33.3	25.4
870928	1600	0.41	0.142	0.083	7.04	11.98	-16.0	-22.0	-27.3	34.7	30.8	24.3
870928	1900	0.55	0.308	0.308	3.25	3.25	-36.0	-26.0	-30.4	31.1	27.6	24.7
870928	2200	0.55	0.289	0.083	3.47	11.98	-42.0	-24.0	-31.1	34.9	31.5	30.4
870929	0100	0.50	0.083	0.083	11.98	11.98	-20.0	-24.0	-28.6	36.0	33.7	33.3
870929	0400	0.55	0.083	0.083	11.98	11.98	-16.0	-26.0	-24.9	32.9	31.9	30.1
870929	0700	0.62	0.250	0.083	4.01	11.98	-32.0	-24.0	-26.3	31.0	31.2	35.5
870929	1000	0.64	0.220	0.083	4.54	11.98	-28.0	-26.0	-23.7	32.0	33.4	26.3
870929	1300	0.59	0.083	0.083	11.98	11.98	-6.0	-26.0	-20.8	33.7	33.7	37.1
870929	1600	0.54	0.083	0.083	11.98	11.98	-16.0	-16.0	-21.0	33.8	33.2	37.4
870929	1900	0.59	0.083	0.083	11.98	11.98	-20.0	-18.0	-18.2	31.1	31.3	32.3
870929	2200	0.66	0.162	0.113	6.19	8.87	-14.0	-14.0	-15.4	31.1	30.5	24.5
870930	0100	0.77	0.123	0.123	8.16	8.16	-20.0	-16.0	-15.2	31.5	31.6	30.1
870930	0400	0.79	0.123	0.123	8.16	8.16	-16.0	-16.0	-16.2	31.1	31.3	27.6
870930	0700	0.77	0.123	0.123	8.16	8.16	-18.0	-18.0	-17.5	29.6	29.4	25.6
870930	1000	0.70	0.123	0.123	8.16	8.16	-14.0	-16.0	-14.7	31.9	32.4	31.3
870930	1900	0.62	0.123	0.123	8.16	8.16	-24.0	-20.0	-22.0	30.4	30.5	28.1
870930	2200	0.69	0.123	0.123	8.16	8.16	-14.0	-14.0	-12.1	30.4	31.6	26.7
871001	0100	0.80	0.113	0.113	8.87	8.87	-18.0	-16.0	8.6	57.2	30.8	32.2
871001	0400	1.00	0.210	0.220	4.75	4.54	40.0	42.0	24.2	50.6	28.3	25.9
871001	0700	1.37	0.191	0.191	5.24	5.24	24.0	22.0	27.4	30.3	27.7	22.6
871001	1000	1.32	0.171	0.171	5.83	5.83	22.0	20.0	26.5	31.2	28.5	25.9
871001	1300	1.09	0.171	0.152	5.83	6.58	18.0	18.0	31.9	34.1	31.6	23.9
871001	1600	0.87	0.181	0.152	5.52	6.58	36.0	42.0	33.4	34.0	26.6	22.1
871001	1900	0.71	0.171	0.162	5.83	6.19	36.0	42.0	32.3	34.2	26.2	21.5
871001	2200	0.62	0.201	0.162	4.98	6.19	36.0	40.0	29.4	41.5	29.6	23.5
871002	0100	0.56	0.181	0.181	5.52	5.52	34.0	38.0	25.9	43.1	30.4	19.8
871002	0400	0.45	0.191	0.113	5.24	8.87	32.0	24.0	14.6	47.0	34.5	27.8
871002	0700	0.42	0.113	0.113	8.87	8.87	-28.0	-22.0	-0.8	45.3	40.1	33.7

(Continued)

Date	Time	H_{mo}	Peak Frequency		Peak Period		Peak Direction			Directional Spread		
	EST	m	$f_{p,FD}$ Hz	$f_{p,IFS}$ Hz	$T_{p,FD}$ sec	$T_{p,IFS}$ sec	$\theta_{p,FD}$ deg	$\theta_{p,IDS}$ deg	$\theta_{p,SW}$ deg	$\Delta\theta_{IDS}$ deg	$\Delta\theta_{SW}$ deg	$\Delta\theta_{FDP}$ deg
871002	1000	0.51	0.113	0.113	8.87	8.87	-18.0	-18.0	-9.3	39.3	38.8	33.7
871002	1300	0.64	0.103	0.113	9.71	8.87	-20.0	-8.0	-25.3	44.8	31.7	31.9
871002	1600	0.69	0.318	0.103	3.15	9.71	-62.0	-60.0	-28.6	47.3	29.0	13.1
871002	1900	0.69	0.113	0.113	8.87	8.87	-12.0	-12.0	-19.7	41.5	31.3	34.0
871002	2200	0.67	0.113	0.113	8.87	8.87	-18.0	-16.0	-22.0	40.2	31.0	36.4
871003	0100	0.60	0.113	0.113	8.87	8.87	2.0	-20.0	-10.2	37.2	35.7	39.0
871003	0400	0.57	0.113	0.113	8.87	8.87	-22.0	-22.0	-19.5	36.2	35.7	36.4
871003	0700	0.51	0.113	0.113	8.87	8.87	-22.0	-22.0	-12.7	33.9	33.9	32.2
871003	1000	0.53	0.123	0.123	8.16	8.16	-18.0	-16.0	-15.7	34.2	34.3	39.6
871003	1300	0.66	0.279	0.123	3.59	8.16	62.0	62.0	12.6	75.2	34.5	14.1
871003	1600	1.12	0.191	0.201	5.24	4.98	48.0	48.0	40.4	39.7	25.3	20.4
871003	1900	1.11	0.181	0.181	5.52	5.52	36.0	42.0	37.1	29.8	22.9	19.9
871003	2200	1.30	0.162	0.162	6.19	6.19	20.0	24.0	31.1	28.6	25.1	23.1
871004	0100	1.47	0.152	0.152	6.58	6.58	12.0	20.0	24.9	30.2	28.1	27.0
871004	0400	1.68	0.142	0.142	7.04	7.04	22.0	16.0	25.4	32.3	30.0	27.0
871004	0700	1.81	0.142	0.142	7.04	7.04	18.0	18.0	19.6	32.1	30.3	29.4
871004	1000	1.51	0.132	0.132	7.56	7.56	24.0	16.0	23.4	33.3	30.9	27.5
871004	1300	1.24	0.142	0.132	7.04	7.56	4.0	10.0	21.6	34.7	31.5	25.3
871004	1600	1.01	0.162	0.142	6.19	7.04	20.0	18.0	29.5	37.3	31.8	25.4
871004	1900	0.82	0.142	0.142	7.04	7.04	22.0	22.0	29.9	35.4	30.5	25.2
871004	2200	0.68	0.142	0.152	7.04	6.58	22.0	16.0	20.8	38.1	30.9	23.4
871005	0100	0.62	0.201	0.201	4.98	4.98	46.0	16.0	26.5	41.8	32.7	34.2
871005	0400	0.59	0.171	0.113	5.83	8.87	14.0	20.0	18.3	40.7	33.3	22.0
871005	0700	0.56	0.123	0.113	8.16	8.87	12.0	16.0	16.6	40.0	33.3	38.7
871005	1000	0.58	0.113	0.113	8.87	8.87	-14.0	12.0	12.1	43.5	34.2	37.5
871005	1300	0.60	0.123	0.123	8.16	8.16	-20.0	12.0	9.4	44.2	35.0	32.7
871005	1600	0.57	0.113	0.113	8.87	8.87	-16.0	16.0	4.3	43.9	34.5	28.7
871005	1900	0.53	0.113	0.113	8.87	8.87	-16.0	6.0	-1.6	39.9	33.7	29.7
871005	2200	0.49	0.113	0.113	8.87	8.87	-20.0	-14.0	-4.5	33.2	31.3	30.1
871006	0100	0.50	0.123	0.123	8.16	8.16	-12.0	-12.0	-9.3	31.2	31.7	33.2
871006	0400	0.49	0.123	0.123	8.16	8.16	-16.0	-16.0	-12.1	32.8	33.3	28.8
871006	0700	0.51	0.103	0.103	9.71	9.71	-14.0	-16.0	-11.6	32.5	32.5	29.7
871006	1000	0.56	0.103	0.103	9.71	9.71	0.0	-20.0	-11.1	31.3	31.2	29.5
871006	1300	0.63	0.103	0.103	9.71	9.71	-14.0	-16.0	-10.0	37.8	38.3	40.8
871006	1600	0.73	0.103	0.103	9.71	9.71	-18.0	-58.0	-24.5	48.3	32.4	42.5
871006	1900	0.74	0.103	0.103	9.71	9.71	10.0	-48.0	-16.2	48.1	32.9	37.6
871006	2200	0.73	0.103	0.103	9.71	9.71	-14.0	-16.0	-19.7	47.4	33.7	40.1
871007	0100	0.79	0.093	0.093	10.72	10.72	-14.0	-16.0	-21.3	45.9	32.8	36.3
871007	0400	0.74	0.103	0.093	9.71	10.72	2.0	-16.0	-12.6	47.3	38.6	41.4
871007	0700	0.72	0.093	0.093	10.72	10.72	12.0	-4.0	-10.4	46.3	39.3	39.2
871007	1000	0.72	0.093	0.093	10.72	10.72	-12.0	-12.0	-13.0	41.2	39.7	41.4
871007	1300	0.80	0.093	0.093	10.72	10.72	-2.0	-14.0	-9.1	39.2	37.8	39.3
871007	1600	0.81	0.103	0.093	9.71	10.72	-4.0	-6.0	-7.0	41.6	39.1	39.8
871007	1900	0.74	0.083	0.083	11.98	11.98	-18.0	-12.0	-12.3	42.8	42.3	38.9
871007	2200	0.74	0.093	0.093	10.72	10.72	-16.0	-20.0	6.4	59.8	34.0	36.9
871008	0100	0.70	0.093	0.093	10.72	10.72	14.0	-18.0	13.8	56.1	34.7	38.7
871008	0400	0.69	0.093	0.093	10.72	10.72	-8.0	58.0	14.4	60.0	35.3	40.2
871008	0700	0.72	0.093	0.093	10.72	10.72	-10.0	56.0	17.6	61.5	33.7	38.5
871008	1000	0.66	0.093	0.093	10.72	10.72	-18.0	22.0	17.6	53.4	34.7	43.0
871008	1300	0.71	0.093	0.093	10.72	10.72	-10.0	24.0	16.4	46.2	33.2	38.3
871008	1600	0.75	0.093	0.093	10.72	10.72	-16.0	22.0	10.0	45.7	33.0	39.0
871008	1900	0.69	0.093	0.093	10.72	10.72	-6.0	26.0	12.0	48.0	32.2	40.8
871008	2200	0.66	0.093	0.093	10.72	10.72	-12.0	32.0	14.3	49.9	33.0	44.2
871009	0100	0.61	0.093	0.093	10.72	10.72	6.0	30.0	16.0	49.5	32.7	42.5
871009	0400	0.72	0.103	0.103	9.71	9.71	0.0	30.0	15.5	48.0	34.2	39.1
871009	0700	0.71	0.103	0.103	9.71	9.71	-12.0	14.0	15.0	48.5	37.3	38.6
871009	1000	0.74	0.103	0.103	9.71	9.71	-4.0	18.0	13.6	47.8	36.7	40.5
871009	1300	0.69	0.103	0.103	9.71	9.71	-12.0	-18.0	2.7	45.7	37.3	40.4
871009	1600	0.66	0.113	0.113	8.87	8.87	8.0	-14.0	5.1	43.4	36.9	36.7
871009	1900	0.66	0.113	0.113	8.87	8.87	-10.0	-12.0	5.1	41.5	39.2	35.8
871009	2200	0.63	0.113	0.113	8.87	8.87	6.0	0.0	1.2	41.1	40.5	37.0
871010	0100	0.59	0.064	0.113	15.62	8.87	-14.0	-14.0	-9.5	39.4	38.5	29.1

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(Continued)

			Peak Frequency		Peak Period		Peak Direction			Directional Spread		
Date	Time EST	H_{mo} m	$f_{p,FD}$ Hz	$f_{p,IFS}$ Hz	$T_{p,FD}$ sec	$T_{p,IFS}$ sec	$\theta_{p,FD}$ deg	$\theta_{p,IDS}$ deg	$\theta_{p,SW}$ deg	$\Delta\theta_{IDS}$ deg	$\Delta\theta_{SW}$ deg	$\Delta\theta_{FDP}$ deg
871010	0400	0.58	0.113	0.113	8.87	8.87	-10.0	-16.0	-11.7	39.6	36.6	34.5
871010	0700	0.57	0.064	0.064	15.62	15.62	-8.0	-18.0	-11.7	37.3	36.3	32.8
871010	1000	0.53	0.064	0.064	15.62	15.62	-4.0	-18.0	-15.3	35.8	33.7	32.4
871010	1300	0.52	0.064	0.064	15.62	15.62	-14.0	-14.0	-15.7	31.3	29.8	29.1
871010	1600	0.52	0.064	0.064	15.62	15.62	-14.0	-14.0	-14.1	33.5	32.2	30.1
871010	1900	0.53	0.064	0.064	15.62	15.62	-8.0	-8.0	-12.0	33.4	32.3	30.0
871010	2200	0.53	0.064	0.064	15.62	15.62	8.0	-8.0	-11.3	34.2	33.6	29.9
871011	0100	0.50	0.064	0.074	15.62	13.57	-18.0	-18.0	-16.1	33.7	33.5	31.1
871011	0400	0.52	0.074	0.074	13.57	13.57	-8.0	-22.0	-17.1	34.2	33.5	27.7
871011	0700	0.60	0.142	0.113	7.04	8.87	-22.0	-22.0	-15.9	37.9	36.4	36.1
871011	1000	0.69	0.142	0.123	7.04	8.16	-22.0	-22.0	-22.8	35.4	33.4	27.3
871011	1300	0.71	0.123	0.123	8.16	8.16	-22.0	-22.0	-21.3	36.0	34.1	37.7
871011	1600	0.73	0.123	0.123	8.16	8.16	-18.0	-20.0	-18.7	34.7	33.1	33.7
871011	1900	0.77	0.113	0.113	8.87	8.87	-24.0	-22.0	-19.9	34.2	33.1	33.4
871011	2200	1.07	0.250	0.113	4.01	8.87	44.0	42.0	15.6	58.7	34.5	31.9
871012	0100	1.94	0.171	0.171	5.83	5.83	8.0	8.0	12.2	37.5	35.8	37.1
871012	04[illegible]	2.33	0.152	0.142	6.58	7.04	2.0	4.0	7.0	37.0	36.5	34.0
871012	0700	2.32	0.142	0.142	7.04	7.04	-2.0	4.0	9.7	37.8	36.7	38.2
871012	1000	2.08	0.142	0.142	7.04	7.04	-2.0	8.0	9.6	38.1	36.6	37.4
871012	1300	1.71	0.142	0.142	7.04	7.04	2.0	6.0	11.7	38.2	35.4	33.2
871012	1600	1.64	0.162	0.162	6.19	6.19	2.0	4.0	9.0	35.9	33.3	32.3
871012	1900	1.67	0.171	0.152	5.83	6.58	6.0	8.0	13.1	35.6	33.6	29.9
871012	2200	1.76	0.171	0.171	5.83	5.83	4.0	8.0	12.2	37.2	34.4	33.1
871013	0100	2.14	0.142	0.142	7.04	7.04	0.0	8.0	11.4	37.3	35.5	41.9
871013	0400	2.49	0.142	0.142	7.04	7.04	4.0	8.0	11.2	36.4	35.9	37.5
871013	0700	2.77	0.142	0.132	7.04	7.56	2.0	10.0	11.9	37.9	37.3	33.9
871013	1000	3.05	0.132	0.132	7.56	7.56	0.0	10.0	8.1	37.8	36.5	39.6
871013	1300	3.03	0.123	0.123	8.16	8.16	2.0	12.0	10.9	39.7	38.1	41.8
871013	1600	3.00	0.123	0.123	8.16	8.16	4.0	8.0	7.0	36.0	36.1	37.8
871013	1900	3.06	0.123	0.123	8.16	8.16	0.0	4.0	8.4	36.4	36.0	39.0
871013	2200	3.10	0.123	0.123	8.16	8.16	12.0	6.0	8.5	37.0	37.1	39.5
871014	0100	3.07	0.123	0.113	8.16	8.87	0.0	4.0	3.8	37.2	37.1	37.7
871014	0400	3.11	0.113	0.113	8.87	8.87	-4.0	6.0	2.6	37.4	37.8	38.9
871014	0700	3.11	0.113	0.113	8.87	8.87	6.0	2.0	6.0	37.6	37.8	41.8
871014	1000	3.05	0.132	0.132	7.56	7.56	-2.0	2.0	8.1	39.1	38.9	38.1
871014	1300	2.91	0.142	0.142	7.04	7.04	-4.0	2.0	5.6	38.6	38.6	35.9
871014	1600	2.84	0.142	0.103	7.04	9.71	-6.0	2.0	4.5	38.8	39.1	34.8
871014	1900	2.74	0.093	0.093	10.72	10.72	18.0	2.0	6.8	38.3	38.8	43.7
871014	2200	2.62	0.093	0.093	10.72	10.72	-2.0	0.0	4.1	39.3	39.4	43.0
871015	0100	2.49	0.083	0.083	11.98	11.98	-12.0	2.0	4.6	40.1	39.8	42.7
871015	0400	2.43	0.083	0.083	11.98	11.98	-14.0	-2.0	-1.1	38.7	39.0	42.5
871015	0700	2.40	0.083	0.083	11.98	11.98	8.0	4.0	6.5	39.5	40.0	42.4
871015	1000	2.41	0.083	0.083	11.98	11.98	2.0	-2.0	-0.5	39.2	39.2	40.7
871015	1300	2.07	0.083	0.083	11.98	11.98	16.0	2.0	7.8	40.2	39.7	39.8
871015	1600	1.95	0.083	0.083	11.98	11.98	-2.0	-4.0	3.2	40.9	40.2	40.3
871015	1900	1.79	0.093	0.093	10.72	10.72	14.0	0.0	4.8	39.3	39.2	41.3
871015	2200	1.81	0.083	0.083	11.98	11.98	8.0	-4.0	2.8	39.3	39.4	41.1
871016	0100	1.77	0.093	0.093	10.72	10.72	12.0	-2.0	1.6	41.3	41.3	42.7
871016	0400	1.59	0.093	0.093	10.72	10.72	0.0	-2.0	0.3	38.3	38.3	36.8
871016	0700	1.46	0.093	0.093	10.72	10.72	-4.0	-10.0	-4.3	40.7	39.6	44.6
871016	1000	1.48	0.093	0.093	10.72	10.72	4.0	-4.0	-0.3	38.6	38.7	38.1
871016	1300	1.37	0.093	0.093	10.72	10.72	-6.0	6.0	1.3	38.1	37.6	40.2
871016	1600	1.33	0.093	0.093	10.72	10.72	-8.0	2.0	-1.9	38.1	37.2	39.1
871016	1900	1.25	0.093	0.093	10.72	10.72	-4.0	6.0	1.0	39.1	38.3	40.3
871016	2200	1.24	0.103	0.103	9.71	9.71	2.0	-6.0	1.6	39.0	38.0	39.2
871017	0100	1.18	0.103	0.103	9.71	9.71	14.0	-8.0	-0.3	39.3	38.8	39.4
871017	0400	1.08	0.103	0.103	9.71	9.71	2.0	0.0	-0.1	38.8	38.4	37.7
871017	0700	1.03	0.103	0.103	9.71	9.71	10.0	-2.0	0.5	38.3	37.2	36.9
871017	1000	1.01	0.103	0.103	9.71	9.71	-2.0	0.0	1.4	36.7	36.2	35.7
871017	1300	1.05	0.103	0.103	9.71	9.71	2.0	-12.0	-0.9	38.4	38.4	37.5
871017	1600	0.96	0.103	0.103	9.71	9.71	-8.0	14.0	0.3	38.8	38.5	35.3
871017	1900	0.93	0.113	0.103	8.87	9.71	2.0	0.0	-1.4	37.6	37.1	35.2
871017	2200	0.95	0.113	0.103	8.87	9.71	-4.0	-6.0	-3.6	36.7	36.0	32.5

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(Continued)

Date	Time EST	H_{mo} m	Peak Frequency $f_{p,FD}$ Hz	$f_{p,IFS}$ Hz	Peak Period $T_{p,FD}$ sec	$T_{p,IFS}$ sec	Peak Direction $\theta_{p,FD}$ deg	$\theta_{p,IDS}$ deg	$\theta_{p,SW}$ deg	Directional Spread $\Delta\theta_{IDS}$ deg	$\Delta\theta_{SW}$ deg	$\Delta\theta_{FDP}$ deg
871018	0100	0.98	0.093	0.103	10.72	9.71	-16.0	12.0	-2.6	38.4	38.1	33.9
871018	0400	0.90	0.103	0.103	9.71	9.71	0.0	12.0	0.3	39.4	38.6	38.5
871018	0700	0.84	0.103	0.103	9.71	9.71	-10.0	-10.0	-3.2	37.9	37.8	38.3
871018	1000	0.95	0.103	0.103	9.71	9.71	4.0	14.0	13.2	39.8	35.0	37.3
871018	1300	1.08	0.103	0.103	9.71	9.71	-8.0	4.0	15.3	38.8	36.2	32.4
871018	1600	1.05	0.103	0.103	9.71	9.71	-8.0	-4.0	1.1	35.3	35.2	38.0
871018	1900	1.00	0.103	0.103	9.71	9.71	-8.0	-6.0	0.5	33.0	32.4	31.8
871018	2200	0.90	0.103	0.103	9.71	9.71	-10.0	-6.0	-1.6	34.8	34.9	34.6
871019	0100	0.86	0.113	0.113	8.87	8.87	0.0	12.0	5.0	35.8	36.0	39.4
871019	0400	0.83	0.103	0.103	9.71	9.71	6.0	10.0	5.2	36.7	35.8	34.4
871019	0700	0.76	0.113	0.103	8.87	9.71	-10.0	14.0	1.5	37.0	36.6	33.0
871019	1000	0.81	0.103	0.113	9.71	8.87	-8.0	-6.0	-0.4	33.7	33.5	29.8
871019	1300	0.81	0.113	0.113	8.87	8.87	-14.0	-10.0	-5.8	36.3	36.4	37.3
871019	1600	0.80	0.123	0.113	8.16	8.87	-10.0	-12.0	-6.7	37.4	37.6	38.2
871019	1900	0.75	0.113	0.113	8.87	8.87	-22.0	-10.0	-8.4	38.5	38.1	39.6
871019	2200	0.74	0.123	0.113	8.16	8.87	2.0	-10.0	-6.2	37.0	37.1	36.6
871020	0100	[illegible]	0.103	0.113	9.71	8.87	6.0	-10.0	-6.3	38.2	38.1	36.6
871020	0400	0.79	0.113	0.103	8.87	9.71	4.0	-12.0	-8.1	38.2	38.3	36.7
871020	0700	0.70	0.113	0.113	8.87	8.87	-6.0	-10.0	-8.6	38.7	38.7	38.7
871020	1000	0.65	0.113	0.113	8.87	8.87	-8.0	-8.0	-5.0	37.3	37.8	39.4
871020	1300	0.67	0.123	0.123	8.16	8.16	-12.0	-10.0	-3.6	38.8	38.9	41.1
871020	1600	0.68	0.113	0.113	8.87	8.87	12.0	-12.0	-3.1	38.3	38.8	39.1
871020	1900	0.64	0.113	0.113	8.87	8.87	8.0	-8.0	-3.1	38.7	38.6	38.1
871020	2200	0.61	0.113	0.113	8.87	8.87	14.0	-4.0	-0.1	39.2	38.8	41.0
871021	0100	0.63	0.123	0.123	8.16	8.16	-14.0	-10.0	-7.9	37.3	37.0	37.1
871021	0400	0.63	0.113	0.113	8.87	8.87	6.0	-10.0	-6.5	39.0	38.0	39.4
871021	1000	0.54	0.083	0.103	11.98	9.71	-10.0	-10.0	-8.9	38.4	38.0	32.5
871021	1300	1.35	0.210	0.210	4.75	4.75	42.0	46.0	38.6	33.9	27.3	19.2
871021	1600	1.24	0.162	0.181	6.19	5.52	36.0	38.0	37.6	40.3	34.8	36.9
871021	1900	1.08	0.162	0.171	6.19	5.83	30.0	14.0	25.6	36.6	33.8	30.5
871021	2200	1.40	0.181	0.181	5.52	5.52	18.0	20.0	25.3	33.4	30.0	27.7
871022	0100	1.52	0.162	0.162	6.19	6.19	8.0	14.0	19.6	34.6	31.0	30.3
871022	0400	1.58	0.152	0.152	6.58	6.58	4.0	16.0	17.5	35.3	32.3	32.2
871022	0700	1.55	0.142	0.142	7.04	7.04	10.0	16.0	20.3	32.9	31.1	27.1
871022	1000	1.42	0.152	0.152	6.58	6.58	6.0	16.0	26.3	31.4	29.1	29.2
871022	1300	1.22	0.181	0.162	5.52	6.19	18.0	12.0	19.1	33.1	31.0	23.7
871022	1600	1.07	0.162	0.162	6.19	6.19	6.0	16.0	15.5	33.2	32.3	28.6
871022	1900	0.83	0.171	0.171	5.83	5.83	4.0	8.0	9.1	35.0	35.1	30.5
871022	2200	0.70	0.201	0.083	4.98	11.98	32.0	8.0	15.2	35.5	33.3	26.6
871023	0100	0.65	0.162	0.093	6.19	10.72	24.0	6.0	12.5	36.4	34.8	33.1
871023	0400	0.63	0.093	0.093	10.72	10.72	14.0	16.0	12.8	37.9	36.8	32.1
871023	0700	0.59	0.093	0.093	10.72	10.72	2.0	2.0	6.4	37.2	35.9	31.9
871023	1000	0.56	0.093	0.093	10.72	10.72	-10.0	-2.0	4.8	35.5	35.1	31.4
871023	1300	0.55	0.083	0.093	11.98	10.72	-6.0	-2.0	-2.4	34.0	34.5	34.4
871023	1600	0.54	0.093	0.093	10.72	10.72	-8.0	-2.0	-4.9	33.6	33.7	33.3
871023	1900	0.54	0.093	0.093	10.72	10.72	-14.0	0.0	-5.7	35.9	36.8	34.0
871023	2200	0.51	0.103	0.103	9.71	9.71	-6.0	0.0	-3.7	33.2	34.2	26.3
871024	0100	0.55	0.113	0.113	8.87	8.87	-6.0	-2.0	-5.1	33.0	33.8	31.0
871024	0400	0.61	0.113	0.132	8.87	7.56	-2.0	-2.0	-7.4	31.8	31.5	31.9
871024	0700	0.62	0.123	0.123	8.16	8.16	2.0	-12.0	-10.5	33.3	33.6	32.9
871024	1000	0.60	0.123	0.123	8.16	8.16	-12.0	-12.0	-10.8	33.3	33.9	32.9
871024	1300	0.62	0.113	0.132	8.87	7.56	-6.0	-10.0	-13.5	33.4	33.2	28.0
871024	1600	0.68	0.123	0.123	8.16	8.16	-18.0	-16.0	-14.6	34.2	34.0	35.2
871024	1900	0.76	0.132	0.132	7.56	7.56	-4.0	-8.0	-13.9	35.8	34.0	31.6
871024	2200	0.72	0.123	0.123	8.16	8.16	-10.0	-6.0	-13.6	35.5	34.2	33.1
871025	0100	0.71	0.123	0.123	8.16	8.16	-8.0	-12.0	-18.6	32.9	32.4	30.7
871025	0400	0.79	0.132	0.132	7.56	7.56	-20.0	-18.0	-17.5	34.1	34.8	34.9
871025	0700	0.89	0.132	0.132	7.56	7.56	-18.0	-20.0	-18.3	34.6	33.7	27.4
871025	1000	1.13	0.240	0.113	4.17	8.87	54.0	56.0	19.6	70.5	33.9	15.8
871025	1300	1.47	0.201	0.201	4.98	4.98	42.0	42.0	32.3	53.5	44.2	50.9
871026	1300	1.23	0.093	0.093	10.72	10.72	-8.0	10.0	7.3	38.9	37.2	35.3
871026	1600	1.25	0.093	0.103	10.72	9.71	-16.0	-4.0	1.2	38.6	37.3	37.4

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Date	Time EST	H_{mo} m	Peak Frequency $f_{p,FD}$ Hz	Peak Frequency $f_{p,IFS}$ Hz	Peak Period $T_{p,FD}$ sec	Peak Period $T_{p,IFS}$ sec	Peak Direction $\theta_{p,FD}$ deg	Peak Direction $\theta_{p,IDS}$ deg	Peak Direction $\theta_{p,SW}$ deg	Directional Spread $\Delta\theta_{IDS}$ deg	Directional Spread $\Delta\theta_{SW}$ deg	Directional Spread $\Delta\theta_{FDP}$ deg
871026	1900	1.23	0.093	0.093	10.72	10.72	-14.0	-6.0	-2.7	38.3	37.9	39.4
871026	2200	1.13	0.093	0.093	10.72	10.72	-4.0	6.0	3.0	40.1	39.0	41.8
871027	0100	1.11	0.093	0.093	10.72	10.72	-2.0	-2.0	5.0	39.7	37.5	37.1
871027	0400	1.02	0.093	0.093	10.72	10.72	-12.0	-6.0	-2.5	40.6	38.2	41.5
871027	0700	0.99	0.093	0.103	10.72	9.71	-12.0	-6.0	-5.5	40.4	40.2	39.3
871027	1000	0.97	0.093	0.103	10.72	9.71	-14.0	-10.0	-7.7	42.2	41.7	40.4
871027	1300	0.97	0.093	0.093	10.72	10.72	-4.0	-14.0	-19.4	49.2	46.4	39.4
871027	1600	1.24	0.142	0.142	7.04	7.04	-28.0	-18.0	-16.4	40.2	39.5	37.0
871027	1900	1.46	0.142	0.142	7.04	7.04	-14.0	-14.0	-14.1	36.8	36.1	32.7
871027	2200	1.32	0.132	0.113	7.56	8.87	-12.0	-12.0	-8.5	37.0	36.0	34.7
871028	0100	1.09	0.113	0.113	8.87	8.87	-14.0	-10.0	-6.5	38.1	37.2	37.3
871028	0400	1.03	0.132	0.132	7.56	7.56	-14.0	42.0	12.6	54.8	31.7	37.2
871028	0700	1.06	0.259	0.113	3.86	8.87	50.0	46.0	20.8	55.5	36.3	28.9
871028	1000	1.05	0.191	0.171	5.24	5.83	44.0	44.0	26.0	54.1	39.1	40.1
871028	1300	0.90	0.181	0.113	5.52	8.87	38.0	42.0	25.1	51.6	41.8	62.2
871028	1600	0.82	0.201	0.113	4.98	8.87	36.0	22.0	20.3	46.8	36.5	28.4
871028	1900	0.78	0.103	0.103	9.71	9.71	4.0	22.0	21.5	45.9	36.0	37.0
871028	2200	0.72	0.103	0.103	9.71	9.71	18.0	22.0	17.6	44.1	35.0	39.1
871029	0100	0.73	0.103	0.103	9.71	9.71	14.0	40.0	17.5	46.2	32.0	40.7
871029	0400	0.90	0.201	0.113	4.98	8.87	30.0	22.0	19.1	41.7	30.5	23.8
871029	0700	0.85	0.191	0.113	5.24	8.87	24.0	24.0	16.4	41.9	33.1	27.4
871029	1000	0.76	0.201	0.103	4.98	9.71	40.0	16.0	11.0	44.1	34.2	30.7
871029	1300	0.68	0.093	0.093	10.72	10.72	-16.0	22.0	8.6	45.8	34.7	37.5
871029	1600	0.58	0.093	0.093	10.72	10.72	14.0	14.0	8.4	45.0	34.6	38.2
871029	1900	0.58	0.103	0.103	9.71	9.71	-10.0	-8.0	3.5	42.2	35.8	35.0
871029	2200	0.55	0.113	0.103	8.87	9.71	-16.0	-12.0	-4.8	39.8	36.2	35.9
871030	0100	0.52	0.103	0.103	9.71	9.71	-16.0	0.0	-8.7	36.8	36.0	34.8
871030	0400	0.48	0.103	0.103	9.71	9.71	-8.0	-2.0	-7.5	37.1	36.9	38.0
871030	0700	0.48	0.093	0.103	10.72	9.71	-10.0	-2.0	-6.0	34.7	34.9	33.0
871030	1000	0.49	0.103	0.103	9.71	9.71	-18.0	-20.0	-12.4	36.1	35.8	35.8
871030	1300	0.51	0.103	0.103	9.71	9.71	-22.0	-20.0	-24.5	39.2	38.6	36.7
871030	1600	0.49	0.103	0.103	9.71	9.71	16.0	-16.0	-9.6	42.0	37.6	39.6
871030	1900	0.50	0.113	0.103	8.87	9.71	-12.0	-14.0	-17.1	36.3	35.8	33.8
871030	2200	0.53	0.103	0.103	9.71	9.71	-4.0	-20.0	-12.8	36.8	36.8	37.7
871031	0100	0.52	0.093	0.093	10.72	10.72	-8.0	-4.0	-14.4	35.4	34.1	34.5
871031	0400	0.48	0.093	0.103	10.72	9.71	-18.0	-6.0	-8.5	33.8	32.8	34.6
871031	0700	0.46	0.103	0.103	9.71	9.71	-10.0	-6.0	-7.3	34.4	32.6	37.6
871031	1000	0.50	0.103	0.103	9.71	9.71	-12.0	-8.0	-10.3	34.7	34.2	36.2
871031	1300	0.50	0.103	0.103	9.71	9.71	-16.0	-8.0	-7.6	36.4	35.0	38.5
871031	1600	0.53	0.103	0.103	9.71	9.71	-6.0	-6.0	-7.9	35.9	35.4	35.6
871031	1900	0.71	0.103	0.103	9.71	9.71	-14.0	10.0	1.5	43.0	33.0	32.4
871031	2200	0.88	0.240	0.103	4.17	9.71	28.0	16.0	13.5	48.5	35.1	24.7
871101	0100	0.92	0.220	0.103	4.54	9.71	44.0	10.0	15.0	48.0	38.5	34.5
871101	0400	0.91	0.220	0.103	4.54	9.71	36.0	10.0	11.6	44.9	37.1	29.2
871101	0700	0.86	0.103	0.103	9.71	9.71	-8.0	10.0	10.9	43.6	38.1	37.7
871101	1000	0.86	0.103	0.113	9.71	8.87	-20.0	-4.0	7.8	44.4	39.7	36.2
871101	1300	0.85	0.113	0.113	8.87	8.87	-10.0	-6.0	1.6	42.3	37.9	39.2
871101	1600	0.82	0.103	0.103	9.71	9.71	-14.0	0.0	-0.2	42.7	36.2	36.0
871101	1900	0.81	0.103	0.103	9.71	9.71	-10.0	-6.0	-2.8	40.8	36.0	39.0
871101	2200	0.84	0.103	0.103	9.71	9.71	-20.0	-4.0	-3.2	40.3	36.0	38.5
871102	0100	0.88	0.113	0.113	8.87	8.87	-14.0	-8.0	-4.5	40.2	36.5	39.1
871102	0400	0.86	0.103	0.113	9.71	8.87	-16.0	-4.0	-6.2	40.4	35.9	33.4
871102	0700	0.87	0.113	0.113	8.87	8.87	-18.0	-10.0	-3.2	40.3	36.1	36.0
871102	1000	0.93	0.113	0.113	8.87	8.87	-10.0	-8.0	-5.6	39.4	35.4	34.3
871102	1300	1.00	0.074	0.113	13.57	8.87	-12.0	-4.0	-5.5	40.0	35.9	31.4
871102	1600	1.00	0.113	0.113	8.87	8.87	-12.0	-4.0	-1.3	42.7	39.3	36.6
871102	1900	0.94	0.074	0.074	13.57	13.57	-18.0	-6.0	-4.2	42.0	39.8	33.4
871102	2200	0.97	0.132	0.074	7.56	13.57	-10.0	-12.0	-2.5	40.1	38.5	30.0
871103	0100	1.07	0.152	0.152	6.58	6.58	-18.0	-20.0	-15.6	38.8	38.5	35.4
871103	0400	1.05	0.132	0.132	7.56	7.56	-6.0	-20.0	-10.6	39.6	39.1	36.1
871103	0700	0.96	0.132	0.132	7.56	7.56	12.0	-20.0	-8.9	40.1	39.9	35.6
871103	1000	0.84	0.132	0.132	7.56	7.56	-10.0	2.0	-10.7	42.3	42.0	35.0

(Continued)

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(Continued)

Date	Time	H_{mo}	Peak Frequency		Peak Period		Peak Direction			Directional Spread		
	EST	m	$f_{p,FD}$ Hz	$f_{p,IFS}$ Hz	$T_{p,FD}$ sec	$T_{p,IFS}$ sec	$\theta_{p,FD}$ deg	$\theta_{p,IDS}$ deg	$\theta_{p,SW}$ deg	$\Delta\theta_{IDS}$ deg	$\Delta\theta_{SW}$ deg	$\Delta\theta_{FDP}$ deg
871103	1300	0.84	0.142	0.142	7.04	7.04	6.0	-18.0	-14.8	39.2	39.5	36.8
871103	1600	0.81	0.142	0.142	7.04	7.04	-10.0	-20.0	-17.8	40.4	39.9	32.4
871103	1900	0.77	0.142	0.142	7.04	7.04	-6.0	-10.0	-10.9	38.8	39.0	36.0
871103	2200	0.73	0.142	0.142	7.04	7.04	-14.0	-16.0	-16.2	38.2	38.4	35.7
871104	0100	0.78	0.142	0.142	7.04	7.04	-4.0	-16.0	-13.0	37.9	37.5	35.8
871104	0400	0.75	0.123	0.132	8.16	7.56	-24.0	-22.0	-21.5	39.5	37.8	36.6
871104	0700	0.69	0.132	0.132	7.56	7.56	-20.0	-26.0	-21.4	40.9	37.6	37.2
871104	1000	0.64	0.123	0.113	8.16	8.87	0.0	-24.0	-15.1	38.1	35.0	33.6
871104	1300	0.64	0.123	0.123	8.16	8.16	-4.0	-18.0	-19.5	35.8	32.7	32.9
871104	1600	0.65	0.113	0.113	8.87	8.87	-18.0	-24.0	-21.2	36.9	33.5	34.2
871104	1900	0.60	0.113	0.113	8.87	8.87	-20.0	-24.0	-20.6	36.1	33.2	33.3
871104	2200	0.53	0.103	0.113	9.71	8.87	-18.0	-22.0	-22.8	33.2	30.8	31.2
871105	0100	0.55	0.123	0.123	8.16	8.16	-18.0	-20.0	-18.5	33.8	32.4	32.5
871105	0400	0.58	0.123	0.113	8.16	8.87	-20.0	-22.0	-24.5	33.2	33.2	35.4
871105	0700	0.57	0.113	0.113	8.87	8.87	-16.0	-24.0	-23.1	33.6	32.4	31.8
871105	1000	0.55	0.113	0.113	8.87	8.87	-18.0	-26.0	-24.1	30.9	30.0	28.6
871105	1300	0.55	0.123	0.123	8.16	8.16	-22.0	-24.0	-25.4	32.0	30.6	27.8
871105	1600	0.98	0.230	0.230	4.35	4.35	50.0	52.0	36.4	60.0	27.6	17.7
871105	1900	1.64	0.171	0.171	5.83	5.83	34.0	38.0	34.5	41.2	39.7	46.4
871105	2200	1.65	0.162	0.162	6.19	6.19	12.0	20.0	28.8	32.9	31.2	32.3
871106	0100	1.74	0.142	0.142	7.04	7.04	2.0	14.0	15.6	33.3	31.0	33.5
871106	0400	2.03	0.142	0.142	7.04	7.04	0.0	12.0	15.7	37.0	34.6	35.2
871106	0700	1.73	0.142	0.142	7.04	7.04	-2.0	10.0	18.9	37.8	35.4	33.6
871106	1000	1.25	0.142	0.142	7.04	7.04	12.0	10.0	18.7	37.8	37.6	33.3
871106	1300	1.00	0.132	0.142	7.56	7.04	10.0	12.0	17.4	32.9	32.5	29.9
871106	1600	0.90	0.162	0.162	6.19	6.19	12.0	14.0	16.9	32.2	31.9	26.5
871106	1900	0.77	0.181	0.171	5.52	5.83	22.0	18.0	22.7	35.9	34.7	26.3
871106	2200	0.64	0.142	0.142	7.04	7.04	14.0	26.0	21.4	36.4	32.4	30.4
871107	0100	0.50	0.152	0.142	6.58	7.04	24.0	10.0	17.3	38.4	33.2	25.8
871107	0700	0.37	0.162	0.162	6.19	6.19	24.0	22.0	8.0	44.5	32.2	21.9
871107	1000	0.33	0.103	0.113	9.71	8.87	-12.0	-6.0	8.8	46.2	34.1	27.4
871107	1300	0.33	0.113	0.113	8.87	8.87	-12.0	-12.0	1.8	37.6	32.1	21.5
871107	1600	0.33	0.113	0.113	8.87	8.87	-16.0	-14.0	-3.0	36.5	34.3	25.0
871107	1900	0.32	0.318	0.113	3.15	8.87	-56.0	-12.0	-17.7	47.1	36.0	56.0
871107	2200	0.30	0.113	0.113	8.87	8.87	-26.0	-16.0	-23.9	37.5	36.7	24.8
871108	0100	0.25	0.103	0.113	9.71	8.87	-16.0	-16.0	-26.6	34.8	35.7	22.5
871108	0700	0.25	0.318	0.123	3.15	8.16	-6.0	-6.0	-20.3	38.2	34.6	34.9
871108	1000	0.24	0.113	0.113	8.87	8.87	-22.0	-24.0	-21.1	34.8	33.0	24.9
871108	1300	0.24	0.123	0.123	8.16	8.16	-18.0	-18.0	-20.1	31.2	29.1	26.2
871108	1600	0.25	0.132	0.132	7.56	7.56	-24.0	-20.0	-25.0	34.8	33.7	25.1
871108	1900	0.30	0.318	0.318	3.15	3.15	-56.0	-50.0	-35.0	41.2	29.2	54.0
871108	2200	0.28	0.123	0.123	8.16	8.16	-28.0	-22.0	-36.2	36.7	32.8	21.6
871109	0100	0.25	0.132	0.123	7.56	8.16	-28.0	-24.0	-30.6	34.9	33.3	21.7
871109	0400	0.26	0.142	0.123	7.04	8.16	-32.0	-24.0	-26.8	35.0	28.5	18.7
871109	0700	0.35	0.250	0.250	4.01	4.01	-38.0	-38.0	-34.8	34.4	29.4	24.1
871109	1000	0.42	0.210	0.201	4.75	4.98	-32.0	-34.0	-40.7	32.3	28.4	26.2
871110	1600	0.81	0.181	0.171	5.52	5.83	-34.0	-36.0	-36.0	31.5	26.6	28.0
871110	2200	1.74	0.171	0.162	5.83	6.19	34.0	38.0	32.9	50.0	38.9	47.4
871111	0100	1.91	0.152	0.152	6.58	6.58	-2.0	16.0	15.3	37.9	33.8	36.2
871111	0400	1.88	0.162	0.152	6.19	6.58	4.0	12.0	11.8	37.2	35.3	34.0
871111	0700	2.05	0.113	0.113	8.87	8.87	18.0	10.0	11.9	40.2	39.2	39.3
871111	1000	1.95	0.103	0.103	9.71	9.71	16.0	6.0	11.6	43.8	41.6	47.4
871111	1300	1.76	0.093	0.093	10.72	10.72	16.0	14.0	22.4	41.3	41.8	42.7
871111	1600	1.84	0.093	0.093	10.72	10.72	12.0	8.0	16.6	35.6	33.4	42.2
871111	1900	2.03	0.132	0.093	7.56	10.72	4.0	14.0	15.8	34.4	31.3	28.5
871111	2200	2.25	0.093	0.093	10.72	10.72	10.0	14.0	15.7	35.3	32.9	40.1
871112	0100	2.38	0.093	0.093	10.72	10.72	-2.0	8.0	9.1	35.9	34.6	40.0
871112	0400	2.45	0.093	0.093	10.72	10.72	2.0	4.0	7.6	35.5	35.3	42.5
871112	0700	2.23	0.093	0.093	10.72	10.72	4.0	8.0	9.0	35.0	34.6	37.8
871112	1000	1.91	0.093	0.093	10.72	10.72	2.0	4.0	6.0	36.6	36.6	39.9
871112	1300	1.58	0.093	0.093	10.72	10.72	-2.0	4.0	2.9	36.1	36.0	42.3
871112	1600	1.25	0.093	0.093	10.72	10.72	-2.0	2.0	6.1	34.4	34.1	40.7

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(Continued)

Date	Time EST	H_{mo} m	Peak Frequency $f_{p,FD}$ Hz	$f_{p,IFS}$ Hz	Peak Period $T_{p,FD}$ sec	$T_{p,IFS}$ sec	Peak Direction $\theta_{p,FD}$ deg	$\theta_{p,IDS}$ deg	$\theta_{p,SW}$ deg	Directional Spread $\Delta\theta_{IDS}$ deg	$\Delta\theta_{SW}$ deg	$\Delta\theta_{FDP}$ deg
871112	1900	0.97	0.093	0.093	10.72	10.72	-2.0	10.0	9.5	35.3	33.5	38.8
871112	2200	0.82	0.093	0.093	10.72	10.72	0.0	4.0	11.0	35.2	33.9	34.3
871113	0100	0.69	0.093	0.093	10.72	10.72	-2.0	8.0	9.4	34.1	33.3	30.4
871113	0400	0.68	0.093	0.093	10.72	10.72	2.0	6.0	3.4	32.7	31.6	33.2
871113	0700	0.63	0.093	0.093	10.72	10.72	6.0	8.0	8.9	35.1	34.5	38.4
871113	1000	0.57	0.083	0.093	11.98	10.72	-8.0	16.0	5.6	37.3	37.1	34.1
871113	1300	0.58	0.093	0.093	10.72	10.72	-14.0	-10.0	-5.2	39.7	39.3	40.8
871114	0100	0.49	0.093	0.093	10.72	10.72	-4.0	0.0	-9.3	38.8	36.7	33.8
871115	0700	0.36	0.318	0.318	3.15	3.15	20.0	6.0	-10.5	40.8	31.8	29.3
871115	1000	0.49	0.298	0.308	3.35	3.25	6.0	-6.0	-4.8	40.6	34.7	32.5
871115	1300	0.51	0.269	0.298	3.72	3.35	40.0	44.0	24.1	55.2	38.8	24.9
871116	0700	0.88	0.171	0.171	5.83	5.83	-2.0	-2.0	5.4	42.3	41.4	32.4
871116	1300	0.82	0.191	0.191	5.24	5.24	-8.0	-8.0	-4.0	39.4	40.3	34.4
871116	2200	0.82	0.162	0.162	6.19	6.19	-14.0	-18.0	-19.0	41.0	40.3	36.3
871117	0400	0.85	0.162	0.152	6.19	6.58	-20.0	-24.0	-22.1	39.6	37.9	36.9
871118	0400	1.37	0.113	0.113	8.87	8.87	-16.0	-22.0	-19.9	36.1	33.6	33.5
871118	0700	1.34	0.113	0.113	8.87	8.87	-6.0	-24.0	-14.5	36.3	35.0	36.4
871118	1000	1.17	0.113	0.113	8.87	8.87	-4.0	-24.0	-12.0	35.1	34.2	36.0
871119	0700	1.63	0.171	0.171	5.83	5.83	4.0	6.0	7.4	38.1	35.5	31.3
871119	1000	1.31	0.171	0.171	5.83	5.83	8.0	2.0	10.1	39.4	36.7	32.5
871119	1600	1.08	0.171	0.171	5.83	5.83	24.0	-8.0	-0.4	43.7	42.0	43.0
871119	1900	0.96	0.123	0.123	8.16	8.16	6.0	-10.0	1.0	45.0	43.7	38.1
871120	0100	1.00	0.220	0.123	4.54	8.16	30.0	-4.0	8.5	43.9	39.2	35.4
871120	0400	0.88	0.132	0.123	7.56	8.16	-12.0	-6.0	3.3	40.2	37.5	30.9
871120	0700	0.74	0.230	0.142	4.35	7.04	6.0	-6.0	2.8	40.3	35.6	29.8
871120	1000	0.60	0.074	0.074	13.57	13.57	-8.0	-8.0	-0.9	37.8	36.1	30.8
871120	1300	0.55	0.074	0.074	13.57	13.57	-14.0	-8.0	1.7	38.0	34.0	31.9
871120	1600	0.63	0.298	0.074	3.35	13.57	56.0	56.0	16.4	57.0	35.3	26.4
871120	1900	0.83	0.210	0.210	4.75	4.75	46.0	52.0	36.1	45.1	29.0	27.0
871120	2200	0.98	0.298	0.220	3.35	4.54	52.0	50.0	36.5	32.4	23.6	23.2
871121	0100	1.37	0.171	0.162	5.83	6.19	28.0	24.0	34.8	32.1	29.0	26.7
871121	0400	1.32	0.171	0.162	5.83	6.19	18.0	20.0	26.9	33.8	29.6	27.1
871121	1300	1.10	0.142	0.171	7.04	5.83	24.0	42.0	31.1	32.3	25.[illegible]	23.7
871121	1600	1.29	0.142	0.142	7.04	7.04	16.0	22.0	29.6	34.5	27.1	26.1
871121	1900	1.47	0.132	0.132	7.56	7.56	12.0	20.0	26.2	35.5	32.4	29.4
871121	2200	1.71	0.142	0.132	7.04	7.56	14.0	18.0	22.1	32.7	28.9	26.3
871122	0100	1.45	0.142	0.132	7.04	7.56	16.0	16.0	22.4	32.2	28.5	24.8
871122	0400	1.36	0.132	0.132	7.56	7.56	20.0	18.0	20.3	34.5	31.3	28.0
871122	0700	1.34	0.142	0.142	7.04	7.04	20.0	18.0	21.4	34.8	31.9	27.6
871122	1000	1.26	0.142	0.123	7.04	8.16	20.0	16.0	21.1	34.0	30.7	25.5
871122	1300	1.05	0.142	0.142	7.04	7.04	10.0	12.0	17.8	32.9	30.9	25.4
871122	1600	0.97	0.132	0.132	7.56	7.56	12.0	10.0	12.3	32.8	32.1	29.3
871122	2200	0.76	0.142	0.142	7.04	7.04	8.0	8.0	13.0	34.1	32.1	30.7
871123	0100	0.63	0.142	0.142	7.04	7.04	24.0	10.0	16.1	33.6	30.0	30.4
871123	0400	0.59	0.142	0.142	7.04	7.04	22.0	14.0	14.0	35.7	31.3	32.6
871123	0700	0.54	0.142	0.142	7.04	7.04	18.0	14.0	9.6	38.9	35.0	36.4
871123	1000	0.45	0.103	0.152	9.71	6.58	-8.0	-2.0	5.6	37.2	34.2	29.0
871123	1300	0.44	0.093	0.083	10.72	11.98	-8.0	-8.0	-1.3	33.5	34.6	22.0
871123	1600	0.45	0.318	0.113	3.15	8.87	-56.0	-12.0	-19.2	41.6	32.4	14.3
871123	1900	0.42	0.113	0.113	8.87	8.87	-16.0	-6.0	-12.3	35.3	34.9	29.5
871123	2200	0.40	0.103	0.103	9.71	9.71	-2.0	-14.0	-12.2	32.6	32.3	31.8
871124	0700	0.38	0.113	0.113	8.87	8.87	-10.0	-14.0	-20.1	39.1	32.0	33.4
871124	1900	0.36	0.113	0.113	8.87	8.87	-12.0	0.0	-18.1	34.8	34.9	30.9
871124	2200	0.36	0.113	0.074	8.87	13.57	-20.0	-2.0	-12.9	36.5	34.7	31.4
871125	0100	0.34	0.113	0.113	8.87	8.87	-20.0	-20.0	-15.2	34.9	33.7	33.3
871125	0400	0.34	0.113	0.123	8.87	8.16	-8.0	-18.0	-13.2	33.5	33.8	33.1
871125	0700	0.34	0.083	0.083	11.98	11.98	-22.0	-4.0	-15.8	36.0	36.0	32.5

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(Continued)

Date	Time EST	H_{mo} m	Peak Frequency $f_{p,FD}$ Hz	Peak Frequency $f_{p,IFS}$ Hz	Peak Period $T_{p,FD}$ sec	Peak Period $T_{p,IFS}$ sec	Peak Direction $\theta_{p,FD}$ deg	Peak Direction $\theta_{p,IDS}$ deg	Peak Direction $\theta_{p,SW}$ deg	Directional Spread $\Delta\theta_{IDS}$ deg	Directional Spread $\Delta\theta_{SW}$ deg	Directional Spread $\Delta\theta_{FDP}$ deg
871125	1000	0.33	0.318	0.113	3.15	8.87	0.0	0.0	-14.5	40.0	39.2	46.7
871125	1300	0.37	0.074	0.074	13.57	13.57	-12.0	0.0	-30.2	45.3	33.8	31.2
871125	1600	0.38	0.083	0.083	11.98	11.98	-26.0	-36.0	-26.8	40.3	33.7	34.3
871125	1900	0.44	0.083	0.083	11.98	11.98	-20.0	-34.0	-26.8	42.1	36.1	37.2
871125	2200	0.53	0.318	0.083	3.15	11.98	0.0	-36.0	-30.3	39.3	34.0	29.6
871126	0100	0.57	0.181	0.181	5.52	5.52	-34.0	-34.0	-25.1	37.7	34.9	29.3
871126	0400	0.68	0.171	0.083	5.83	11.98	-32.0	-30.0	-29.7	36.5	34.9	31.7
871126	0700	0.85	0.142	0.083	7.04	11.98	-8.0	-26.0	-22.5	34.1	33.2	29.1
871126	1000	0.93	0.142	0.083	7.04	11.98	-28.0	-28.0	-22.9	35.1	34.2	27.5
871126	1300	0.89	0.083	0.083	11.98	11.98	-20.0	-26.0	-21.8	35.0	34.0	34.5
871126	1600	0.82	0.113	0.113	8.87	8.87	-24.0	-26.0	-19.5	33.5	32.9	30.8
871126	2200	0.88	0.093	0.113	10.72	8.87	-2.0	-28.0	-16.2	38.7	37.3	37.0
871127	0100	0.82	0.113	0.113	8.87	8.87	-10.0	-24.0	-21.4	38.2	36.1	34.6
871127	0400	0.94	0.113	0.113	8.87	8.87	-18.0	-8.0	-2.2	42.4	39.7	37.0
871127	0700	1.62	0.171	0.181	5.83	5.52	32.0	0.0	8.2	47.2	43.2	45.0
871127	1000	2.10	0.152	0.152	6.58	6.58	-8.0	-6.0	7.2	42.8	41.6	39.4
871127	1300	2.14	0.142	0.132	7.04	7.56	-8.0	-4.0	-1.3	42.2	41.1	36.9
871127	1600	2.08	0.132	0.123	7.56	8.16	-4.0	-6.0	1.5	43.1	41.5	40.3
871127	1900	2.21	0.123	0.123	8.16	8.16	-8.0	0.0	1.5	41.6	41.3	43.9
871127	2200	2.14	0.123	0.123	8.16	8.16	0.0	-6.0	-1.0	42.4	43.1	49.3
871128	0100	1.98	0.113	0.113	8.87	8.87	8.0	-4.0	-1.0	44.1	43.8	43.3
871128	0400	1.99	0.113	0.113	8.87	8.87	2.0	-2.0	-2.6	41.8	41.5	42.6
871128	0700	1.93	0.132	0.132	7.56	7.56	-10.0	-6.0	-2.8	42.7	41.9	41.5
871128	1300	1.98	0.132	0.123	7.56	8.16	-12.0	-10.0	-2.5	44.5	44.1	42.9
871128	1600	2.04	0.123	0.123	8.16	8.16	8.0	10.0	1.6	42.2	41.5	40.0
871128	1900	2.03	0.113	0.113	8.87	8.87	10.0	0.0	1.8	40.7	40.6	41.9
871128	2200	1.94	0.123	0.123	8.16	8.16	4.0	-2.0	-3.4	42.8	42.4	40.8
871129	0100	1.93	0.113	0.113	8.87	8.87	18.0	-10.0	-2.8	43.7	43.6	43.8
871129	0400	1.93	0.123	0.123	8.16	8.16	-4.0	-10.0	-1.2	43.9	43.7	42.9
871129	0700	1.90	0.123	0.113	8.16	8.87	0.0	-10.0	-2.4	42.2	41.7	42.7
871129	1000	2.04	0.113	0.113	8.87	8.87	14.0	-12.0	-1.4	41.7	41.2	42.8
871129	1300	2.17	0.093	0.093	10.72	10.72	-2.0	-14.0	-5.5	41.0	40.8	39.3
871129	1600	2.08	0.093	0.093	10.72	10.72	-2.0	-16.0	-12.5	40.1	39.9	36.7
871129	1900	1.98	0.093	0.093	10.72	10.72	-2.0	-16.0	-2.8	38.8	38.5	37.2
871129	2200	1.89	0.103	0.103	9.71	9.71	2.0	-16.0	-4.2	41.2	40.3	41.8
871130	0100	1.73	0.103	0.103	9.71	9.71	4.0	-16.0	-8.6	42.1	41.1	41.7
871130	0400	1.58	0.103	0.103	9.71	9.71	-4.0	-6.0	-5.4	40.1	40.0	41.5
871130	0700	1.48	0.103	0.103	9.71	9.71	10.0	-14.0	-1.9	39.6	39.1	40.7
871130	1000	1.49	0.103	0.103	9.71	9.71	4.0	-2.0	-3.4	38.0	38.0	38.5
871130	1300	1.79	0.083	0.083	11.98	11.98	-10.0	-10.0	-1.5	43.5	40.9	40.0
871130	1600	1.79	0.083	0.083	11.98	11.98	-22.0	-12.0	1.4	45.8	40.4	41.2
871130	1900	1.75	0.083	0.083	11.98	11.98	0.0	-12.0	6.9	42.8	41.9	42.9
871130	2200	2.10	0.083	0.083	11.98	11.98	0.0	-6.0	3.0	40.0	39.5	39.6
871201	0100	1.90	0.083	0.083	11.98	11.98	-8.0	-6.0	-2.0	42.5	41.1	41.3
871201	0700	1.64	0.083	0.083	11.98	11.98	0.0	-8.0	3.7	41.3	39.8	39.9
871201	1000	1.49	0.083	0.083	11.98	11.98	-10.0	-10.0	-0.8	39.5	39.1	37.4
871201	1300	1.24	0.083	0.083	11.98	11.98	-2.0	-10.0	-1.4	40.7	40.4	40.4
871201	1600	1.01	0.083	0.083	11.98	11.98	0.0	-12.0	-1.7	40.7	40.1	37.0
871201	1900	0.92	0.083	0.083	11.98	11.98	-8.0	-12.0	-6.2	39.6	39.6	38.9
871202	0100	0.73	0.083	0.083	11.98	11.98	-18.0	-16.0	-16.2	37.2	37.3	37.8
871202	1600	0.50	0.083	0.083	11.98	11.98	-4.0	-2.0	-2.0	40.8	41.4	36.6
871202	2200	0.49	0.083	0.083	11.98	11.98	-2.0	0.0	1.0	38.5	38.9	33.3
871208	1300	0.55	0.113	0.113	8.87	8.87	-14.0	-4.0	-1.0	36.4	36.6	32.6
871208	1600	0.56	0.123	0.123	8.16	8.16	-2.0	-12.0	-6.5	35.6	36.5	35.2
871208	1900	0.58	0.132	0.123	7.56	8.16	-10.0	-10.0	-9.6	36.6	37.1	32.5
871208	2200	0.56	0.132	0.132	7.56	7.56	-8.0	-14.0	-6.6	37.0	36.7	31.2
871209	0100	0.53	0.103	0.123	9.71	8.16	-10.0	-12.0	-5.5	36.4	36.9	33.1
871209	0400	0.53	0.142	0.123	7.04	8.16	2.0	0.0	-2.1	35.5	36.0	30.9
871209	0700	0.52	0.113	0.123	8.87	8.16	-16.0	-6.0	-6.0	34.4	34.5	28.4
871209	1000	0.48	0.103	0.113	9.71	8.87	-18.0	-4.0	-10.1	36.2	36.3	32.9
871209	1300	0.46	0.103	0.103	9.71	9.71	-18.0	-18.0	-12.7	36.3	36.3	36.0

(Continued)

(Sheet 10 of 11)

(Concluded)

Date	Time	H_{mo}	Peak Frequency		Peak Period		Peak Direction			Directional Spread		
	EST	m	$f_{p,FD}$ Hz	$f_{p,IFS}$ Hz	$T_{p,FD}$ sec	$T_{p,IFS}$ sec	$\theta_{p,FD}$ deg	$\theta_{p,IDS}$ deg	$\theta_{p,SW}$ deg	$\Delta\theta_{IDS}$ deg	$\Delta\theta_{SW}$ deg	$\Delta\theta_{FDP}$ deg
871209	1600	0.46	0.113	0.113	8.87	8.87	-4.0	-4.0	-15.0	42.3	40.1	40.4
871209	1900	0.48	0.103	0.103	9.71	9.71	-18.0	-18.0	-20.8	41.2	36.4	34.4
871209	2200	0.46	0.113	0.113	8.87	8.87	-14.0	-16.0	-19.6	41.7	34.6	38.1
871210	0100	0.43	0.123	0.113	8.16	8.87	-16.0	-18.0	-18.6	39.0	34.0	33.5
871210	0400	0.41	0.123	0.123	8.16	8.16	-10.0	-14.0	-22.4	38.9	33.7	33.4
871210	1000	0.41	0.113	0.113	8.87	8.87	-12.0	-30.0	-22.6	40.3	36.1	34.1
871210	1300	0.43	0.113	0.113	8.87	8.87	-16.0	-16.0	-27.7	40.0	35.5	38.2
871213	1900	0.69	0.171	0.103	5.83	9.71	22.0	26.0	13.4	42.2	39.1	29.0
871213	2200	0.65	0.201	0.181	4.98	5.52	30.0	28.0	14.1	39.8	37.2	31.2
871214	0100	0.64	0.201	0.103	4.98	9.71	34.0	30.0	19.9	38.7	35.5	37.1
871214	0400	0.71	0.220	0.220	4.54	4.54	34.0	24.0	20.8	40.0	34.8	33.7
871215	1300	1.06	0.152	0.152	6.58	6.58	-22.0	-26.0	-27.1	48.5	37.9	40.3
871215	1600	1.06	0.298	0.123	3.35	8.16	-66.0	-36.0	-29.0	43.5	33.6	17.6
871216	1000	0.70	0.240	0.230	4.17	4.35	52.0	52.0	28.0	64.8	27.5	12.3
871216	1600	0.81	0.240	0.220	4.17	4.54	54.0	56.0	38.2	51.6	31.1	19.4
871216	1900	0.63	0.220	0.220	4.54	4.54	52.0	56.0	36.7	52.2	30.8	26.0
871217	1000	1.23	0.181	0.181	5.52	5.52	26.0	42.0	32.9	37.3	31.4	28.8
871217	1300	1.63	0.142	0.142	7.04	7.04	10.0	20.0	19.3	34.9	33.0	36.8
871219	2200	0.83	0.083	0.083	11.98	11.98	-4.0	-6.0	-5.2	16.6	17.9	11.7
871220	0100	0.76	0.083	0.083	11.98	11.98	-4.0	-4.0	-5.4	24.5	24.8	21.4
871220	0400	0.67	0.083	0.083	11.98	11.98	-2.0	-2.0	-3.2	24.4	24.7	21.2
871220	0700	0.64	0.083	0.083	11.98	11.98	-6.0	-6.0	-5.2	21.9	23.0	17.9
871220	1300	0.61	0.093	0.093	10.72	10.72	-8.0	-6.0	-16.0	43.1	29.4	35.1
880104	1900	0.86	0.113	0.123	8.87	8.16	10.0	0.0	6.1	45.1	43.8	45.2
880104	2200	0.73	0.113	0.113	8.87	8.87	18.0	-10.0	1.0	45.1	44.3	45.6
880105	0100	0.61	0.113	0.113	8.87	8.87	16.0	12.0	3.3	43.6	42.7	43.9
880106	0100	0.80	0.191	0.191	5.24	5.24	38.0	40.0	28.9	42.0	29.8	30.2
880106	1900	0.88	0.162	0.152	6.19	6.58	6.0	6.0	13.0	35.7	34.4	27.0
880109	2200	0.92	0.103	0.113	9.71	8.87	-6.0	25.0	13.5	44.1	39.6	45.0

(Sheet 11 of 11)

Appendix B: Time Series Graphs of Bulk Spectral Parameters, Wind Vector, and Current Vector

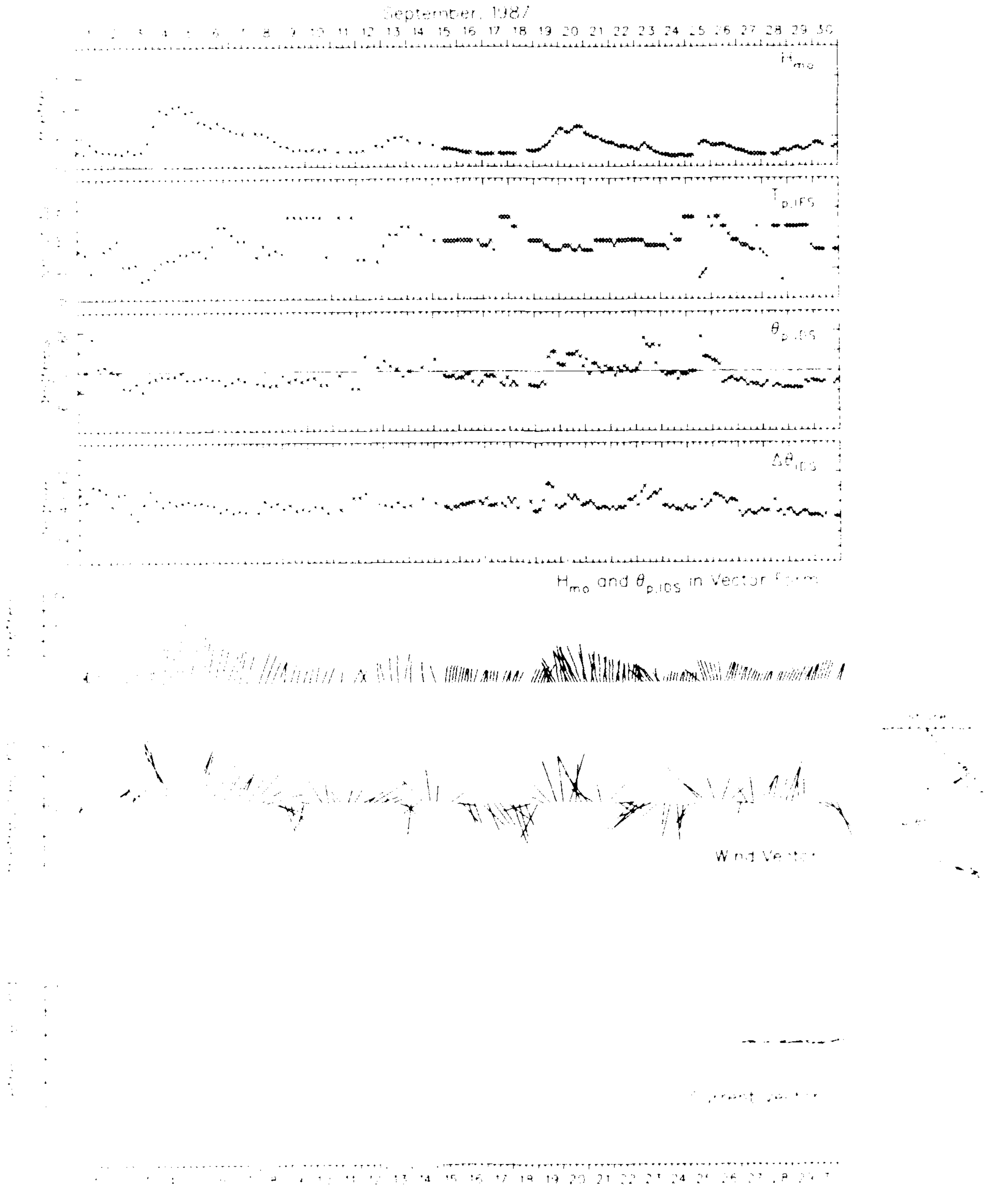

Figure B1. Bulk data for September 1987

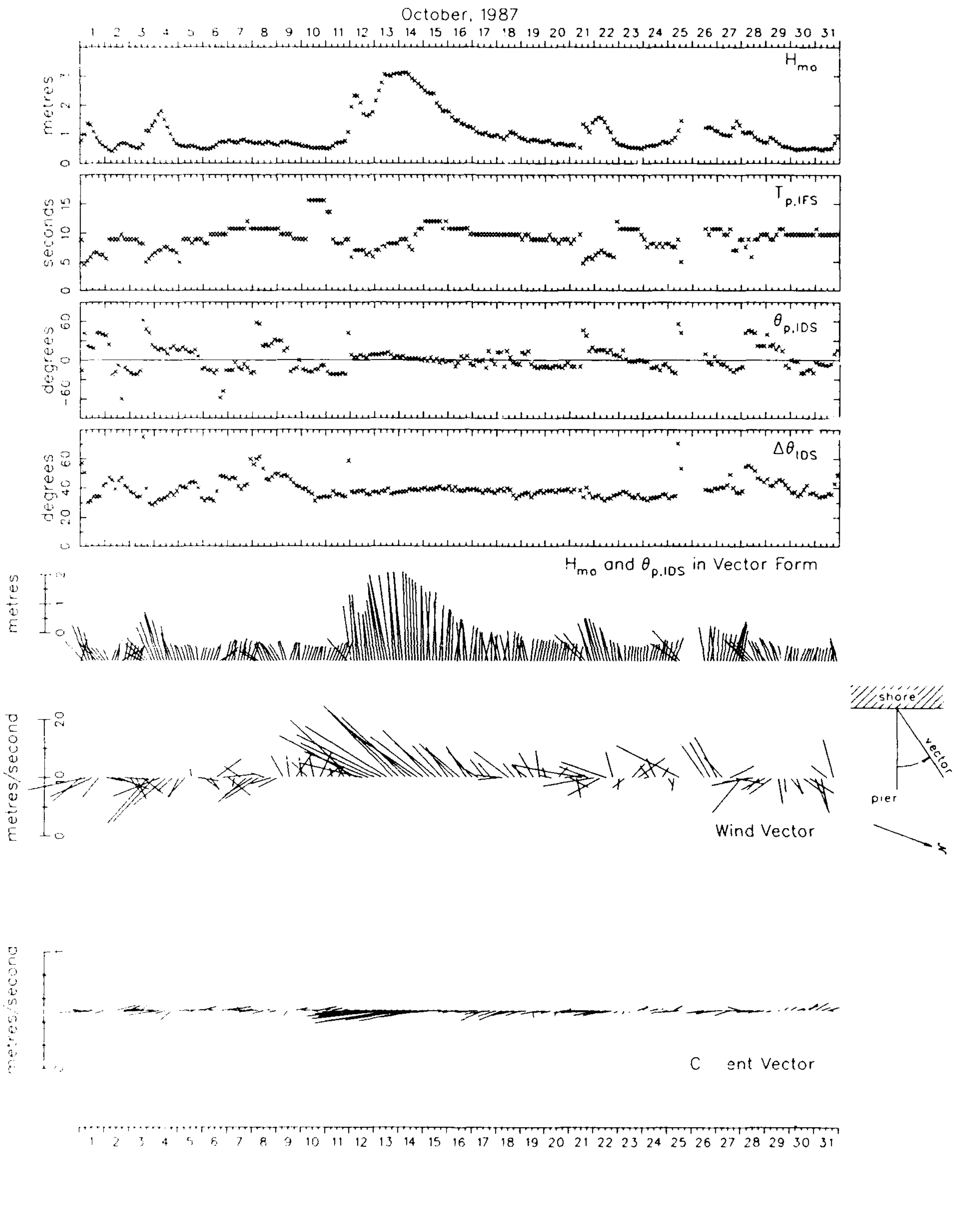

Figure B2. Bulk data for October 1987

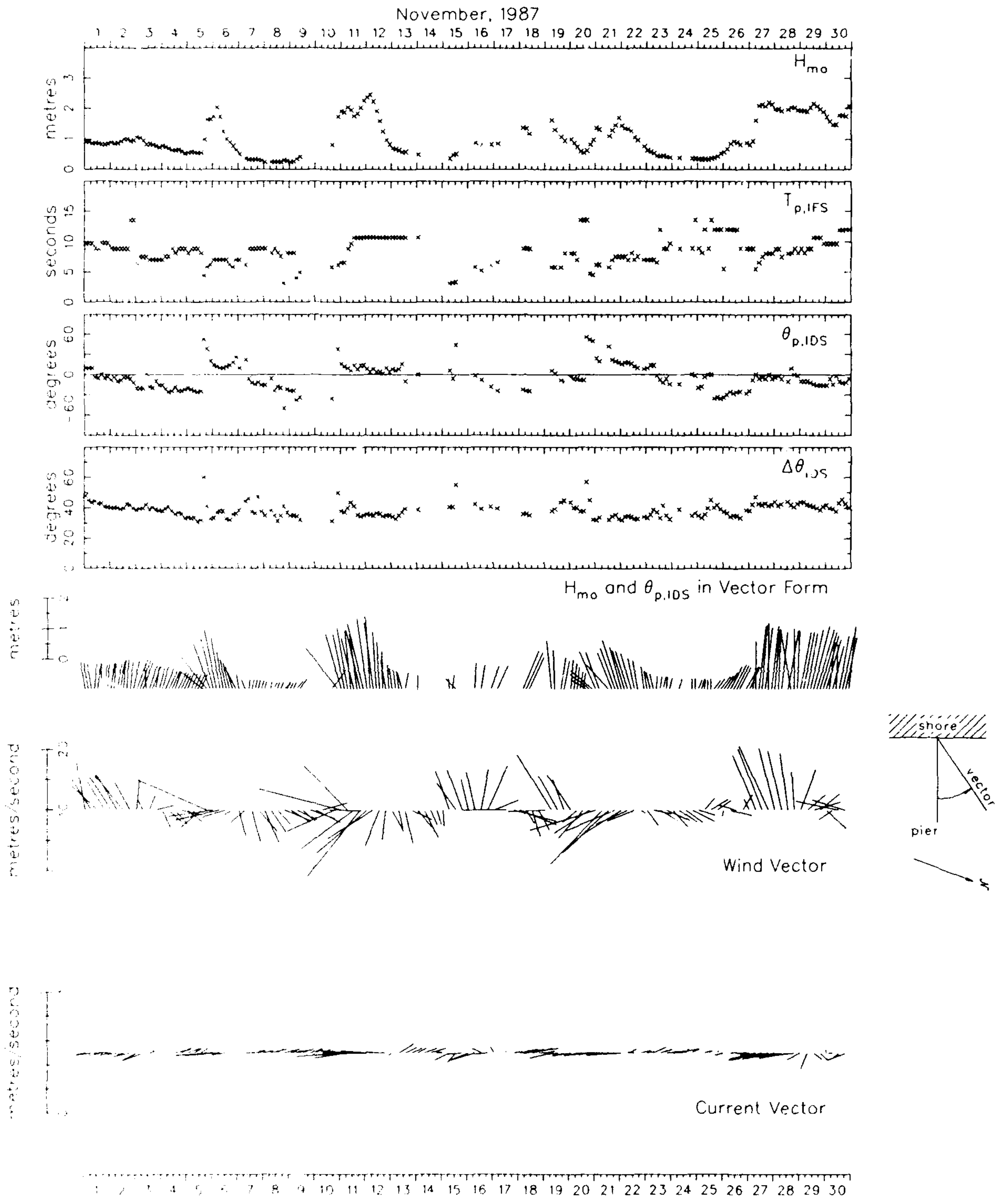

Figure B3. Bulk data for November 1987

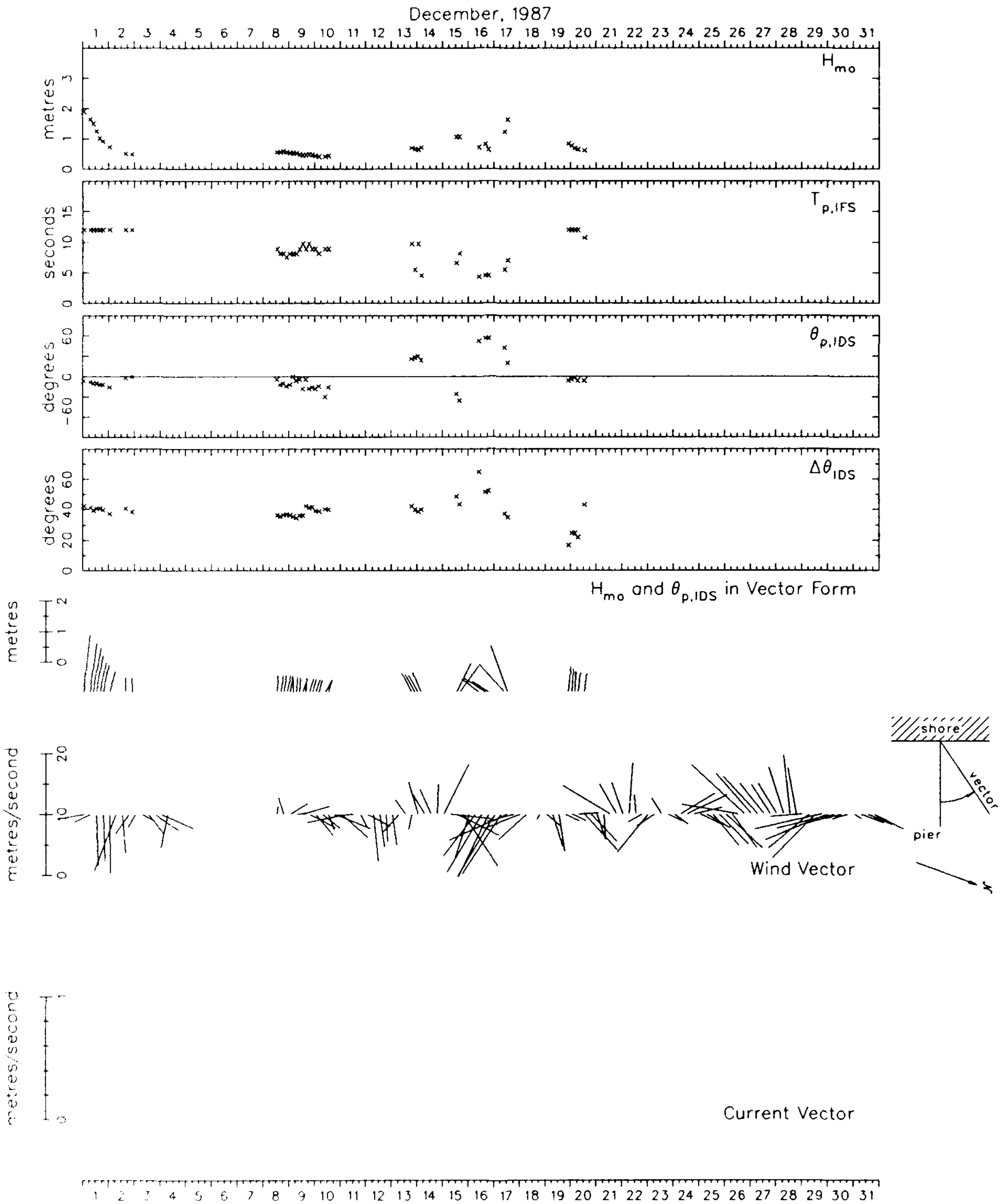

Figure B4. Bulk data for December 1987

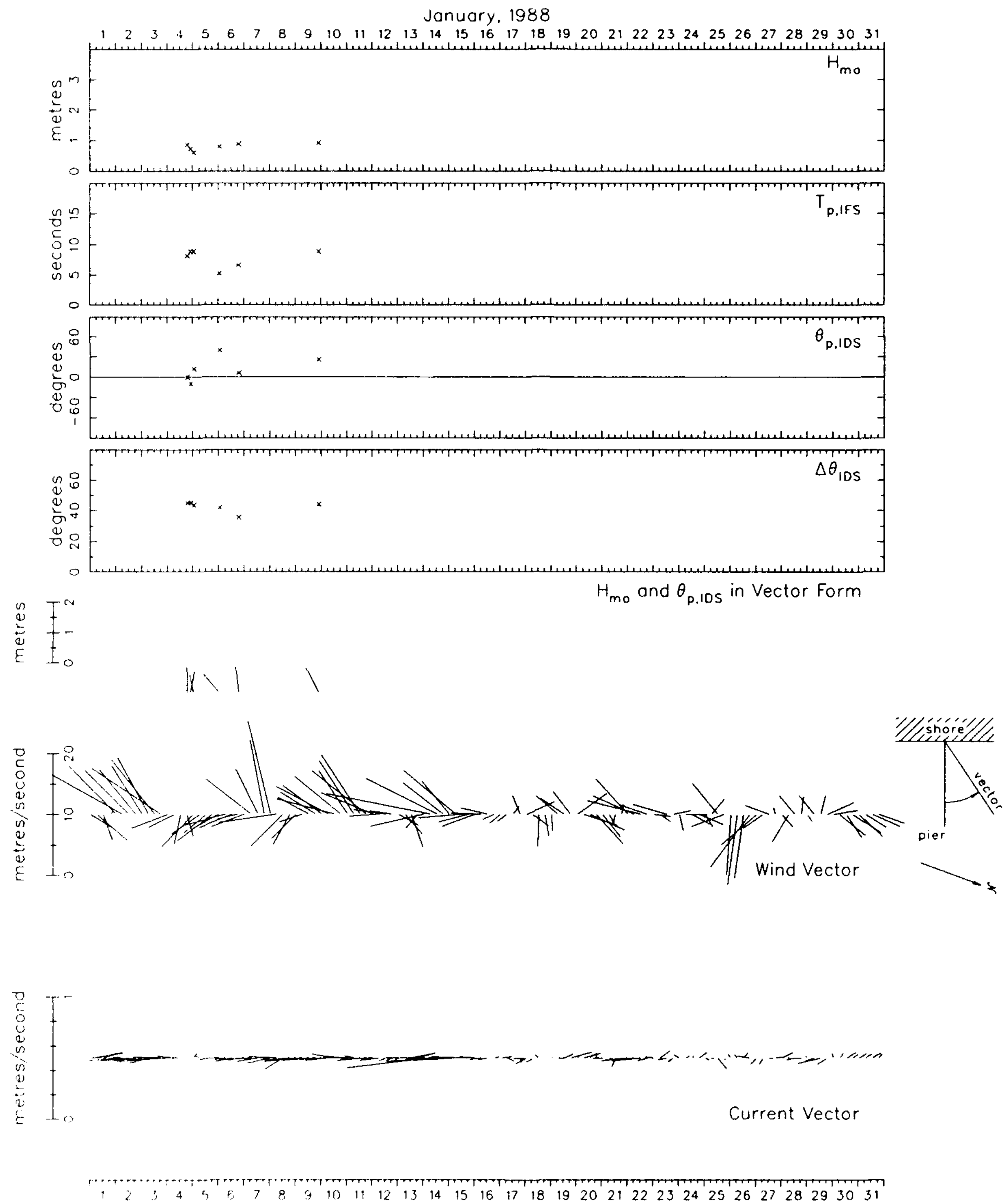

Figure B5. Bulk data for January 1988

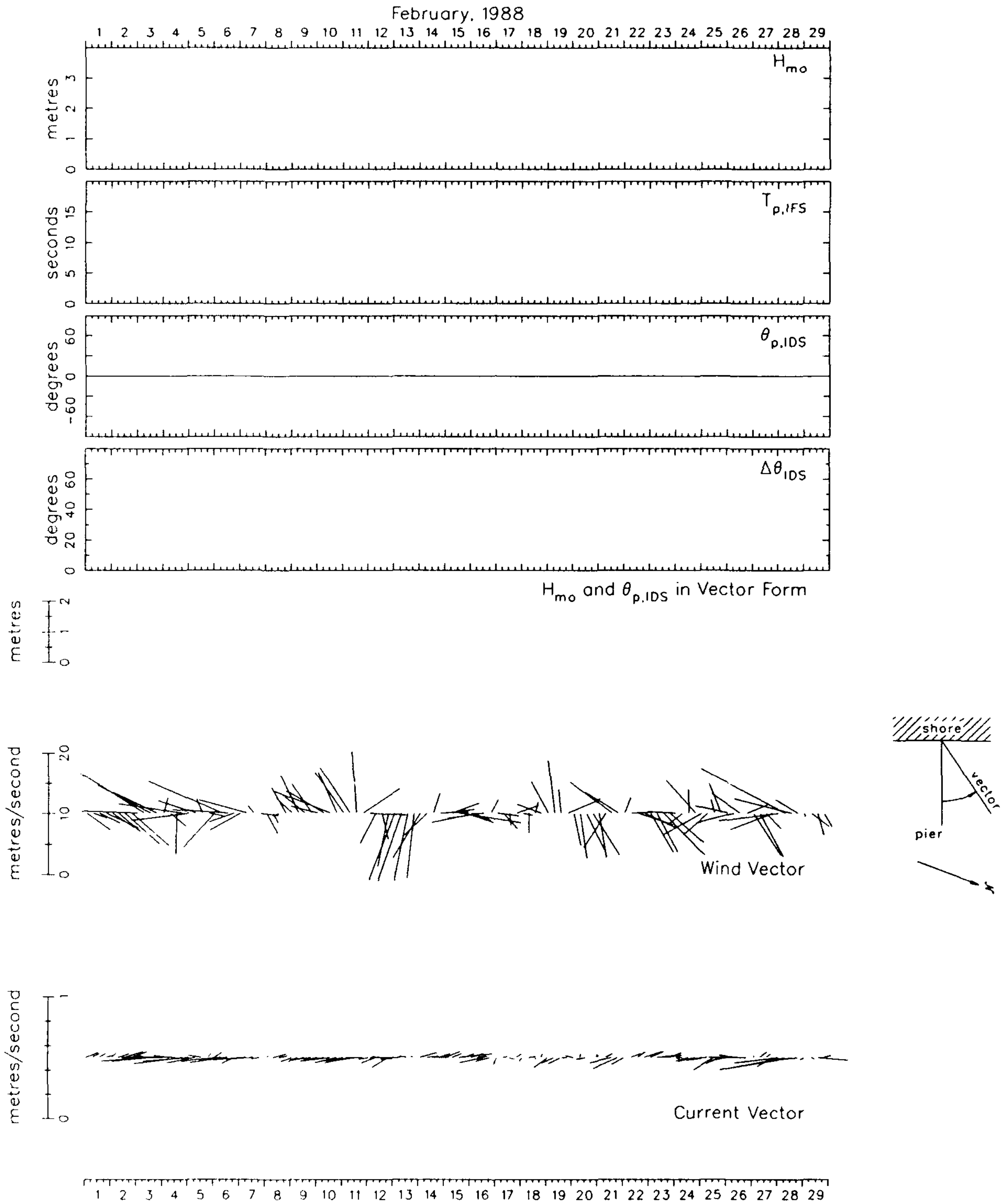

Figure B6. Bulk data for February 1988

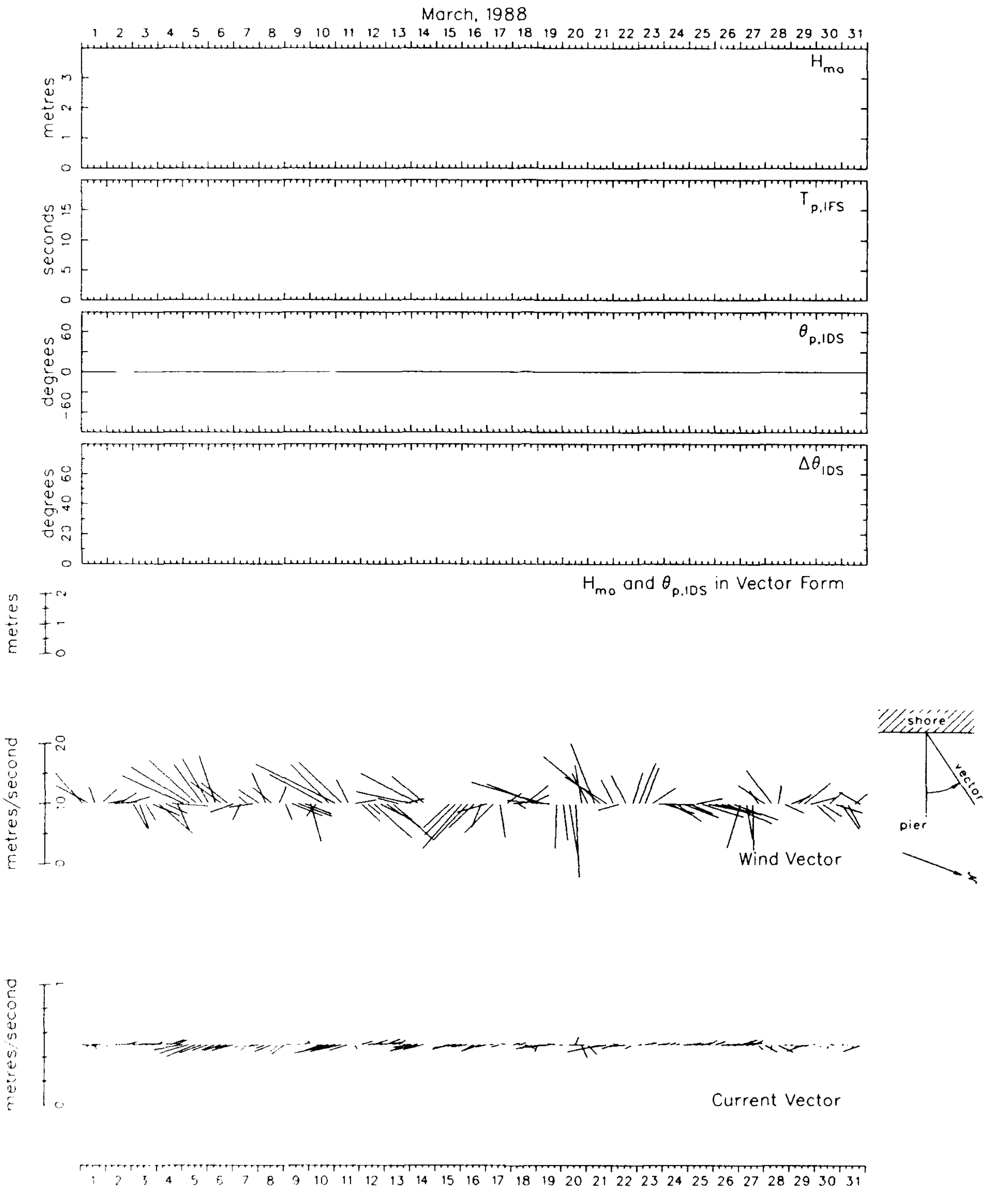

Figure B7. Bulk data for March 1988

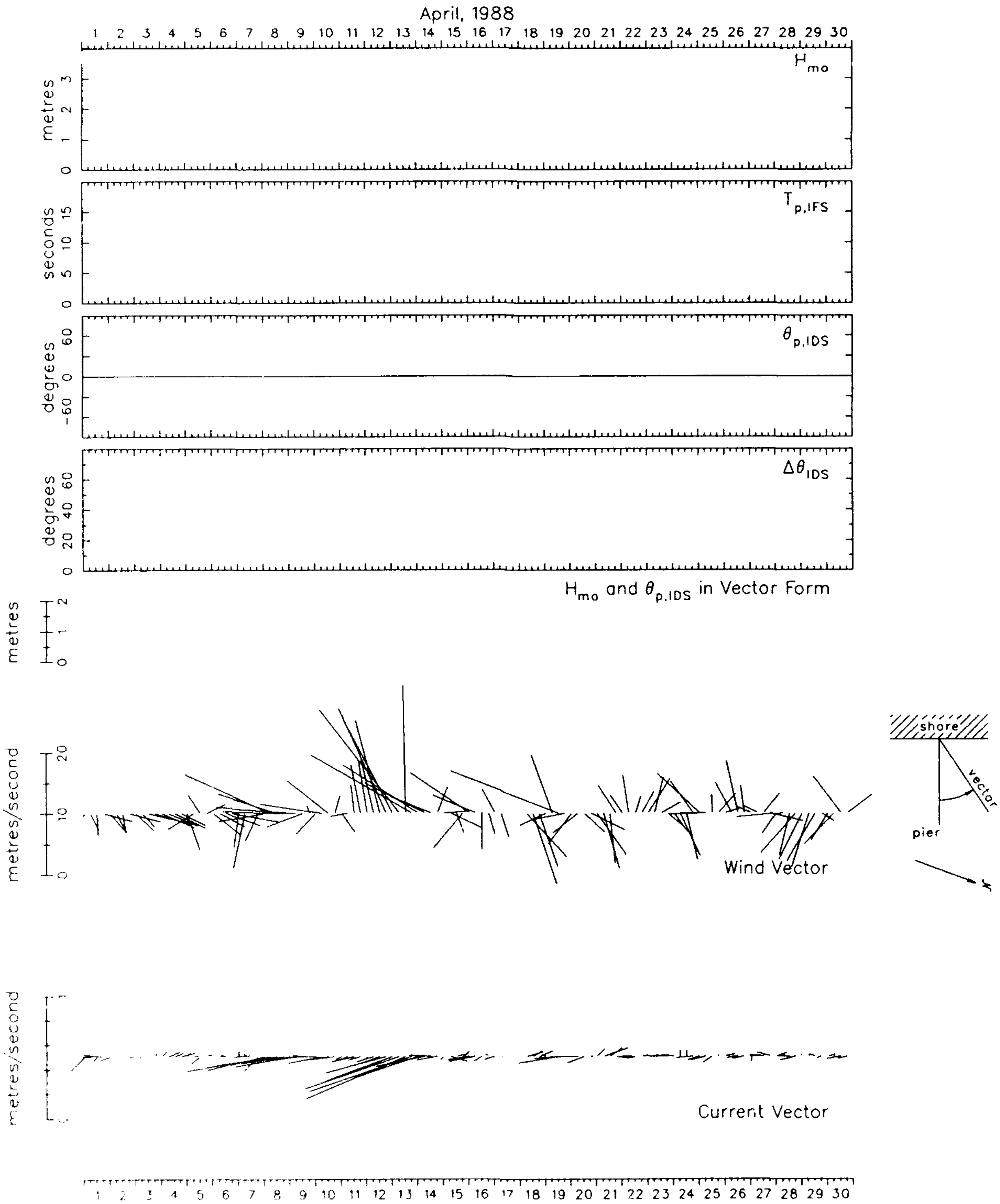

Figure B8. Bulk data for April 1988

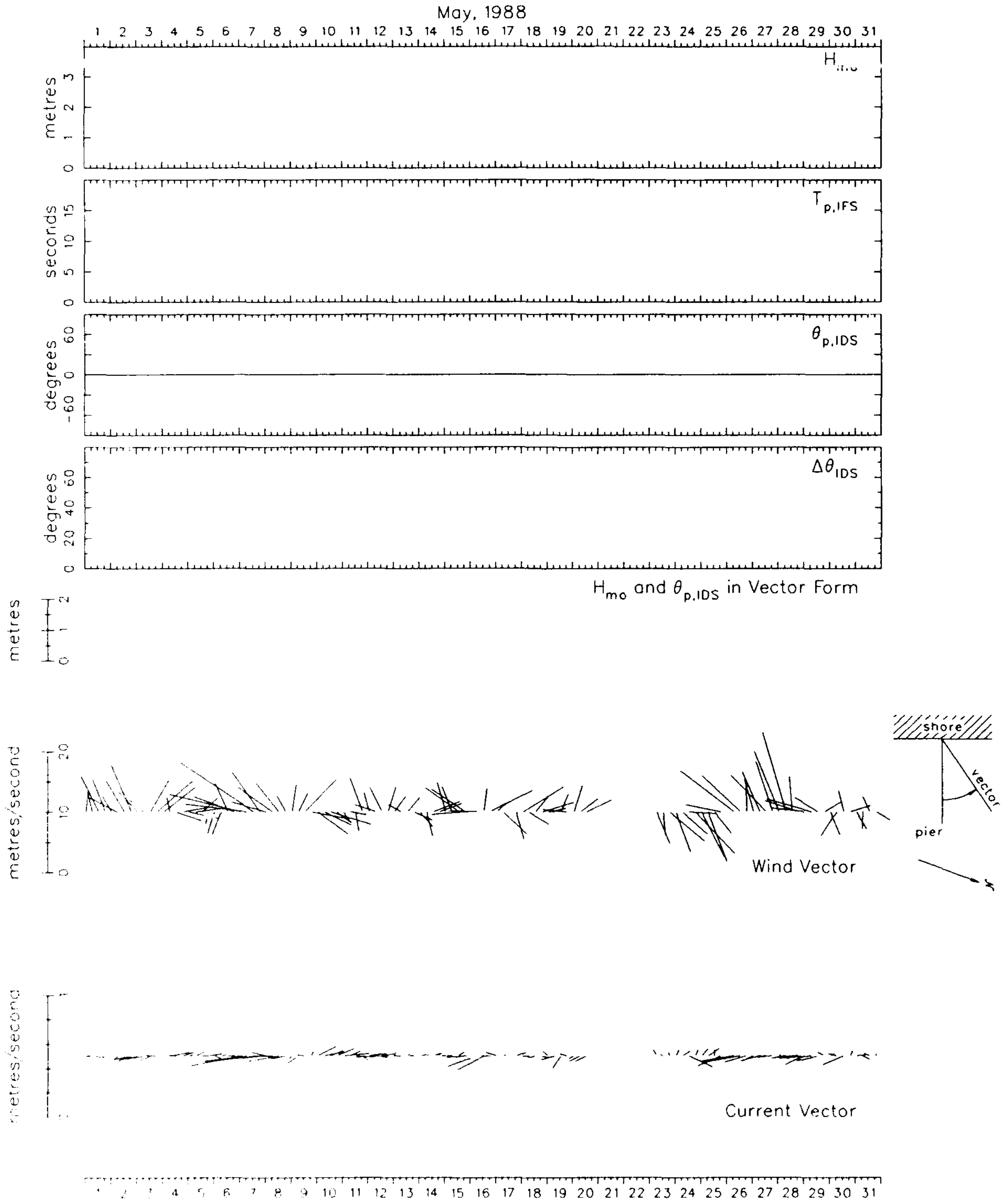

Figure B9. Bulk data for May 1988

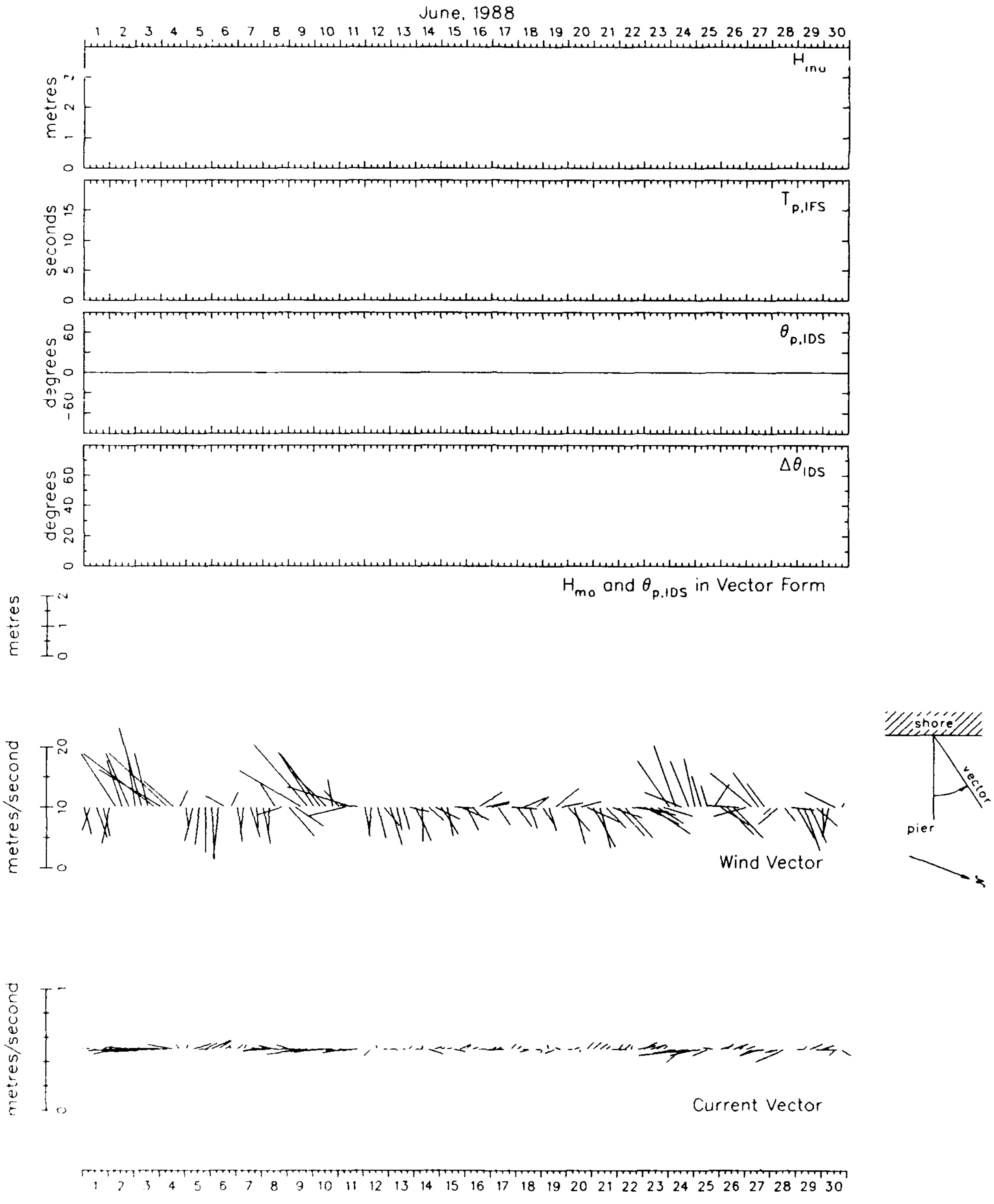

Figure B10. Bulk data for June 1988

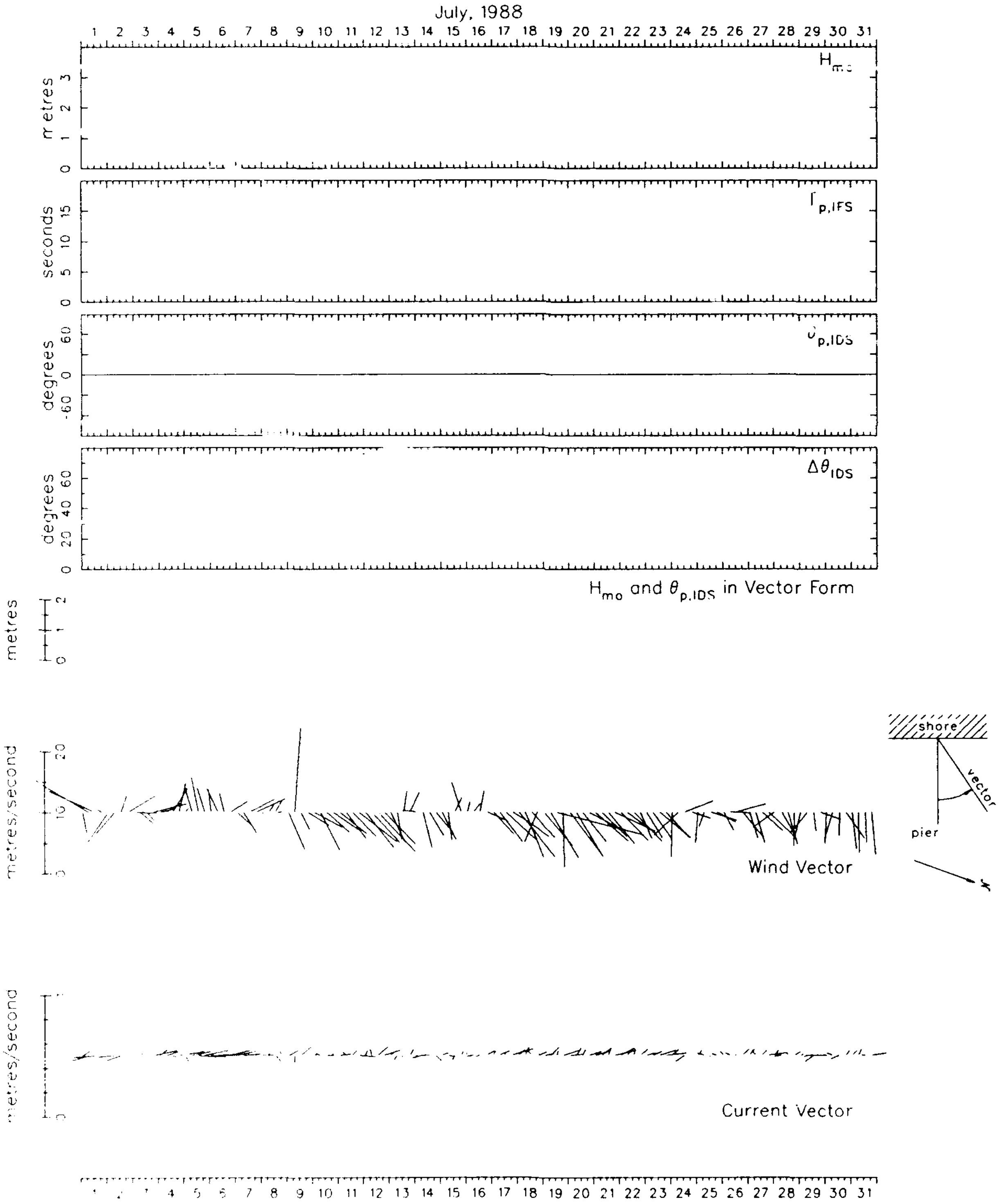

Figure B11. Bulk data for July 1988

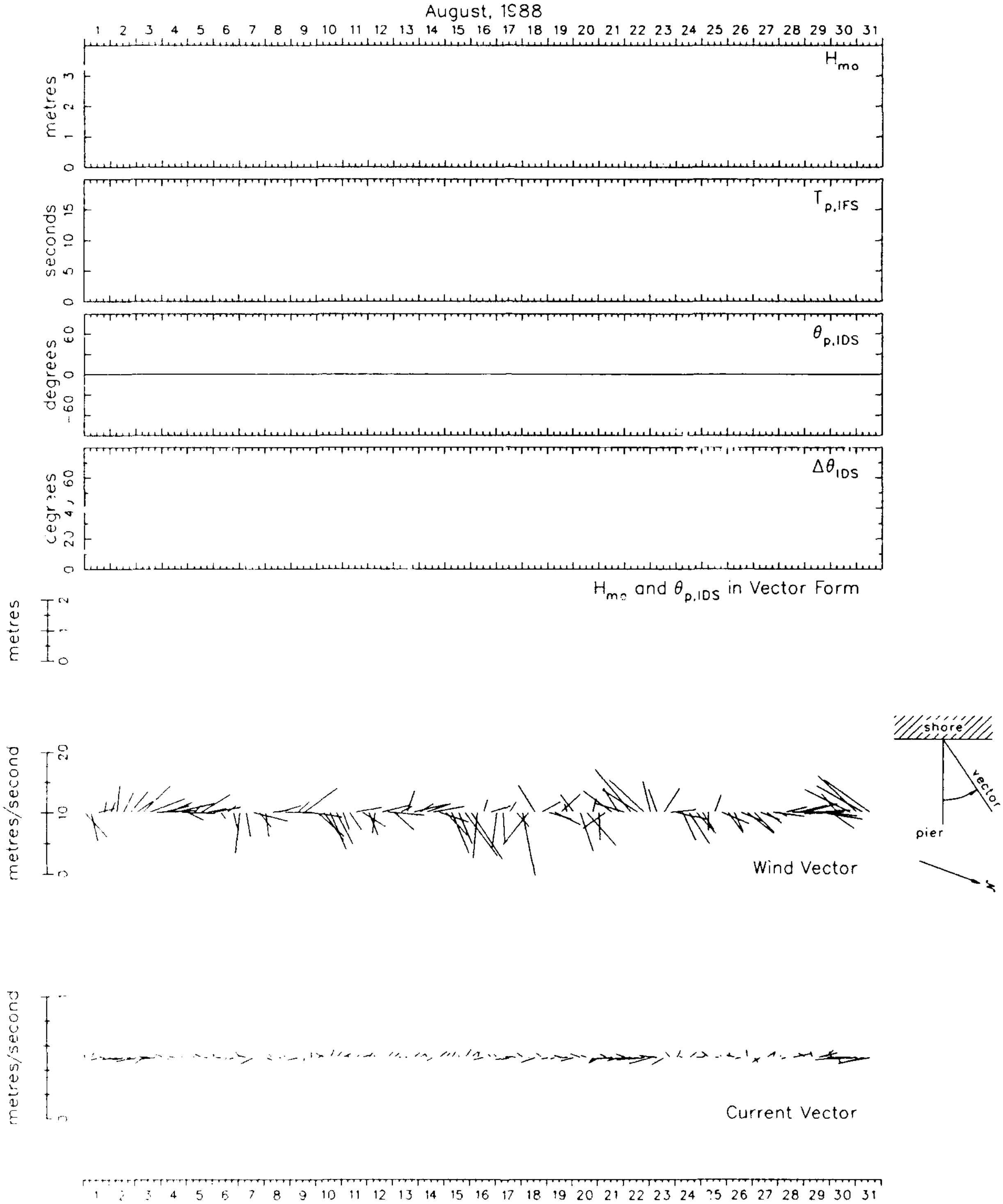

Figure B12. Bulk data for August 1988

Appendix C: Listing of FORTRAN Computer Program

```
      PROGRAM READUM
C***********************************************************************
C   This program illustrates DIMENSION and FORMAT definitions nec-     *
C essary to read wave energy frequency-direction spectral data         *
C tiles representing measurements made with a high resolution lin-    *
C ear array directional wave gage at the USAE/WES/CERC Field           *
C Research Facility in Duck, NC.                                       *
C   The program is written in FORTRAN-77 and should be universal in    *
C that sense.  However, it uses VAX 11/750 file access statements      *
C ('OPEN' and 'CLOSE') to open data files for reading.  It is like-    *
C ly that some changes will be necessary to read data files which      *
C have been transferred to another system.                             *
C   The data files themselves are ASCII formatted with 80-column       *
C records.                                                             *
C   Variables are listed and defined below.  A distinction is made     *
C between 'universal' and 'system-dependent' variables to help         *
C in adapting this code to another system.                             *
C                                                                      *
C ==================================================================== *
C                           VARIABLE LIST                              *
C .................................................................... *
C                     ---------------------------                      *
C                 .oO[  UNIVERSAL VARIABLES  ]Oo.                      *
C                     ---------------------------                      *
C                                                                      *
C    NAME                       MEANING                                *
C  --------                     -------                                *
C                                                                      *
C       IHM.....[CHARACTER*4] Start time of a 2 hr 16 min collec-      *
C               tion.  It has the form  hhmm  where  hh  is hour       *
C               (24-hour clock) and  mm  is minute.  Time base is      *
C               Eastern Standard Time.                                 *
C                                                                      *
C      IYMD.....[CHARACTER*6] Start year, month and day of a collec-   *
C               tion.  It has the form  yymmdd  where  yy  is year,    *
C               mm  is month and  dd  is day.  For example,  861012    *
C               is 12 October 1986.                                    *
C                                                                      *
C      GPAT.....[CHARACTER*9] Nine-character string representing the  *
C               pattern of operating gages by showing gage identifi-   *
C               cation numbers in sequence from north to south and     *
C               indicating malfunctioning gages by a minus sign.  If   *
C               all nine gages are working, the pattern is 987123456.  *
C               If, for example, gage 7 was malfunctioning, the pat-   *
C               tern becomes 98-123456 and data will have been pro-    *
C               cessed as if gage 7 did not exist.  Accuracy is de-    *
C               graded slightly but results are still valid.           *
C                                                                      *
C     DEPTH.....[REAL, in meters] Mean total water depth at the lin-   *
C               ear array during a 2 hr 16 min collection.             *
C                                                                      *
C        NF.....[INTEGER] Number of frequency bands in the discrete    *
C               spectral representations.                              *
C                                                                      *
C        ND.....[INTEGER] Number of direction bands in the discrete    *
C               spectral representations.                              *
C                                                                      *
C      D(J).....[READ, in degrees] J'th element of array represent-    *
C               ing wave direction, which is the direction from        *
C               which waves are coming counterclockwise from shore     *
C               normal;  0.0 degrees is shore normal, positive         *
C               angles are for waves from the northeast quadrant,      *
C               negative angles are for southeast quadrant.  Direc-    *
C               tions are considered to reside in the centers of       *
C               discrete direction bands (or bins or arcs).            *
C                                                                      *
C     DS(J).....[REAL, in meters squared per degree] J'th element      *
C               of array representing direction spectrum.  This is     *
C               the directional analogy of the frequency spectrum,     *
C               being the integral of the frequency-direction spec-    *
C               trum over all frequencies (in the analysis pass        *
C               band) of sea surface displacement variance in each     *
C               direction band.                                        *
C                                                                      *
C      F(N).....[REAL, in Hertz] N'th element of array representing    *
C               frequency.  Considered the center frequency of a       *
C               discrete frequency band.                               *
C                                                                      *
C     FS(N).....[REAL, in meters squared per Hertz] N'th element of    *
```

```
C                 array representing the frequency spectrum.  Here, it *
C                 is the integral of the frequency-direction spectrum  *
C                 over all directions in each frequency band.  It is   *
C                 the same as the conventional frequency spectrum that *
C                 one would get with a single time series.             *
C                                                                      *
C  DD(N,J).....[REAL, in 1/degrees] Element at N'th frequency and     *
C                 J'th direction of an entity known as the directional *
C                 distribution function.  It is defined as the ratio   *
C                 of the frequency-direction spectrum to the frequency *
C                 spectrum at each frequency for all directions, i.e., *
C                                                                      *
C                             DD(N,J) = FDS(N,J)/FS(N)                 *
C                                                                      *
C                 The directional distribution is convenient in sever- *
C                 al ways for normalizing the frequency-direction      *
C                 spectrum, but note that it is physically meaningful  *
C                 only for a fixed frequency (N = constant) since a    *
C                 different normalizing factor is used at each fre-    *
C                 quency.                                              *
C                                                                      *
C FDS(N,J).....[REAL, in meters squared per Hertz per degree] Fre-     *
C                 quency-direction spectral density of sea surface     *
C                 displacement at frequency F(N) and direction D(J).   *
C                 It is determined from the input data by the compu-   *
C                 tation of                                            *
C                                                                      *
C                             FDS(N,J) = FS(N)*DD(N,J)                 *
C                                                                      *
C ==================================================================== *
C                                                                      *
C                   ----------------------------------                 *
C               .oO[   SYSTEM-DEPENDENT VARIABLES    ]Oo.              *
C                   ----------------------------------                 *
C                                                                      *
C DATETIME.....[CHARACTER*10] Ten-character string requested of       *
C                 default input device.  It contains year, month, day, *
C                 hour and minute in the form  yymmddhhmm  and is used *
C                 to form the name of an input file.                   *
C                                                                      *
C DATAFILE.....[CHARACTER*16] String representing input file name     *
C                 in an 'OPEN' statement.                              *
C                                                                      *
C****************************************MYRNA LOY, FEB90*************
      CHARACTER*4     IHM
      CHARACTER*6     IYMD
      CHARACTER*9     GPAT
      CHARACTER*10    DATETIME
      CHARACTER*16    DATAFILE
      DIMENSION       F(28),FS(28),D(91),DS(91)
      DIMENSION       DD(28,91),FDS(28,91)
C**********************************************************************
C SET GENERIC DATAFILE NAME, GET SPECIFIC DATE AND TIME FROM USER     *
C AND SET SPECIFIC DATAFILE NAME.                                      *
C**********************************************************************
      DATAFILE='FDyymmddhhmm.DAT'                !GENERIC FILE NAME
      WRITE(*,'(1X,
     1   ''Enter Date/Time Code (yymmddhhmm)....: '',
     2   $)')                                     !PROMPT USER
      READ(*,'(A)') DATETIME                      !GET USER RESPONSE
      DATAFILE(3:12)=DATETIME                     !SET FILE NAME
C**********************************************************************
C OPEN DATA FILE, READ FORMATTED DATA AND CLOSE DATA FILE.  NOTE:     *
C THE VARIABLE 'NN' IS THE FREQUENCY INDEX WHICH HAS BEEN WRITTEN     *
C TO THE DATA FILE TO MAKE IT EASY TO READ THE FILE BY HAND.  HERE    *
C IT IS NOT NEEDED SO IT IS READ TO A DUMMY VARIABLE.                  *
C**********************************************************************
      OPEN(10,FILE=DATAFILE,STATUS='OLD',
     1   FORM='FORMATTED',RECL=80)                !VAX 'OPEN' STATEMENT
      READ(10,101) IYMD,IHM,GPAT,DEPTH,NF,ND     !AUX. PARAMETERS
      READ(10,102) (D(J),J=1,ND)                  !DIRECTIONS
      READ(10,103) (DS(J),J=1,ND)                 !DIRECTIONAL SPECTRUM
      DO 1 N=1,NF                                 !FOR ALL FREQ.'S
      READ(10,104) NN,F(N),FS(N)                  !FREQ. & FREQ. SPECT.
      READ(10,105) (DD(N,J),J=1,ND)               !DIR. DISTRIBUTION
    1 CONTINUE                                    !END FREQ. LOOP
      CLOSE(10)                                   !VAX 'CLOSE'
C**********************************************************************
C FORMAT STATEMENTS:                                                   *
C**********************************************************************
```

```
  101 FORMAT(1X,A6,A4,1X,A9,1X,F6.2,1X,I2,1X,I2)
  102 FORMAT(13(1X,F5.1))
  103 FORMAT(5(1X,E14.7))
  104 FORMAT(1X,I2,1X,F9.6,1X,E14.7)
  105 FORMAT(8(1X,F9.6))
C**************************************************************************
C  BUILD FREQUENCY-DIRECTION SPECTRUM FROM DIRECTIONAL DISTRIBUTION  *
C  ARRAY AND FREQUENCY SPECTRUM.                                     *
C**************************************************************************
      DO 2 N=1,NF                                  !FOR ALL FREQ.'S
      DO 3 J=1,ND                                  !FOR ALL DIR.'S
      FDS(N,J)=FS(N)*DD(N,J)                       !SET F-D SPECTRUM
    3 CONTINUE                                     !END DIR. LOOP
    2 CONTINUE                                     !END FREQ. LOOP
C**************************************************************************
C  AT THIS POINT YOU SHOULD HAVE ALL THE DATA THERE IS.  INSERT YOUR *
C  OWN CODE HERE...                                                  *
C**************************************************************************
C**************************************************************************
C  END PROGRAM.                                                      *
C**************************************************************************
      END                                          !BAG IT
```

Appendix D: Listing of Sample Data File

```
8709020100 987123456   7.90 28 91
 90.0  88.0  86.0  84.0  82.0  80.0  78.0  76.0  74.0  72.0  70.0  68.0  66.0
 64.0  62.0  60.0  58.0  56.0  54.0  52.0  50.0  48.0  46.0  44.0  42.0  40.0
 38.0  36.0  34.0  32.0  30.0  28.0  26.0  24.0  22.0  20.0  18.0  16.0  14.0
 12.0  10.0   8.0   6.0   4.0   2.0   0.0  -2.0  -4.0  -6.0  -8.0 -10.0 -12.0
-14.0 -16.0 -18.0 -20.0 -22.0 -24.0 -26.0 -28.0 -30.0 -32.0 -34.0 -36.0 -38.0
-40.0 -42.0 -44.0 -46.0 -48.0 -50.0 -52.0 -54.0 -56.0 -58.0 -60.0 -62.0 -64.0
-66.0 -68.0 -70.0 -72.0 -74.0 -76.0 -78.0 -80.0 -82.0 -84.0 -86.0 -88.0 -90.0
 0.1167792E-06  0.5409858E-06  0.1083458E-05  0.1651731E-05  0.2242338E-05
 0.2880442E-05  0.3569934E-05  0.4307840E-05  0.5149377E-05  0.6057168E-05
 0.7099094E-05  0.8228590E-05  0.9572657E-05  0.1106660E-04  0.1291891E-04
 0.1523226E-04  0.1821464E-04  0.2221194E-04  0.2742593E-04  0.3416645E-04
 0.4255921E-04  0.5281700E-04  0.6469394E-04  0.7925725E-04  0.9684869E-04
 0.1203391E-03  0.1500250E-03  0.1796816E-03  0.1995005E-03  0.2011157E-03
 0.1884106E-03  0.1740599E-03  0.1660481E-03  0.1653399E-03  0.1691091E-03
 0.1743641E-03  0.1799804E-03  0.1861262E-03  0.1920343E-03  0.1986725E-03
 0.2051720E-03  0.2078082E-03  0.2069661E-03  0.2040164E-03  0.1999825E-03
 0.1962159E-03  0.1921510E-03  0.1882644E-03  0.1858432E-03  0.1847035E-03
 0.1864722E-03  0.1885444E-03  0.1902147E-03  0.1875799E-03  0.1811386E-03
 0.1720343E-03  0.1615534E-03  0.1527699E-03  0.1460418E-03  0.1404094E-03
 0.1346902E-03  0.1277933E-03  0.1207465E-03  0.1133819E-03  0.1059528E-03
 0.9842022E-04  0.9182294E-04  0.8733469E-04  0.8294491E-04  0.8206345E-04
 0.8193295E-04  0.8188710E-04  0.8072078E-04  0.7773956E-04  0.7283616E-04
 0.6775146E-04  0.6284544E-04  0.5834065E-04  0.5428750E-04  0.4993110E-04
 0.4538757E-04  0.4045033E-04  0.3518839E-04  0.2993183E-04  0.2487027E-04
 0.2005206E-04  0.1553978E-04  0.1137421E-04  0.7386998E-05  0.3653181E-05
 0.8208105E-06
 1  0.054200  0.1409651E-01
 0.000000  0.000027  0.000063  0.000081  0.000126  0.000144  0.000254  0.000254
 0.000414  0.000414  0.000734  0.000788  0.001133  0.001271  0.001614  0.001872
 0.002075  0.002345  0.002354  0.002376  0.002328  0.002039  0.002039  0.001675
 0.001675  0.001460  0.001424  0.001392  0.001379  0.001465  0.001529  0.001684
 0.001891  0.002077  0.002541  0.002682  0.003529  0.003529  0.005013  0.005013
 0.007042  0.007381  0.010497  0.011744  0.015189  0.017773  0.019713  0.022300
 0.021872  0.020802  0.020151  0.016242  0.016242  0.013223  0.013223  0.012939
 0.012891  0.014167  0.014677  0.015530  0.016170  0.015559  0.014744  0.013600
 0.010742  0.010195  0.006912  0.006912  0.004590  0.004590  0.003396  0.003197
 0.002666  0.002453  0.002153  0.001928  0.001770  0.001559  0.001468  0.001240
 0.001195  0.000928  0.000928  0.000669  0.000669  0.000459  0.000424  0.000273
 0.000213  0.000091  0.000000
 2  0.063960  0.1385702E-01
 0.000000  0.000053  0.000089  0.000160  0.000177  0.000323  0.000357  0.000494
 0.000596  0.000750  0.000912  0.001020  0.001239  0.001294  0.001442  0.001432
 0.001393  0.001306  0.001176  0.001017  0.000910  0.000764  0.000728  0.000614
 0.000608  0.000584  0.000608  0.000644  0.000745  0.000812  0.001081  0.001148
 0.001742  0.001926  0.002664  0.003156  0.003895  0.004672  0.005190  0.006183
 0.006431  0.007895  0.008334  0.010088  0.011084  0.012577  0.013705  0.014456
 0.014778  0.014858  0.014418  0.014493  0.014792  0.015829  0.017386  0.020338
 0.022307  0.025083  0.025777  0.023179  0.021830  0.016430  0.014110  0.010630
 0.008605  0.007255  0.005867  0.005520  0.004740  0.004653  0.004303  0.004156
 0.003934  0.003659  0.003476  0.003028  0.002915  0.002306  0.002193  0.001738
 0.001555  0.001280  0.001039  0.000878  0.000652  0.000596  0.000347  0.000312
 0.000174  0.000104  0.000000
 3  0.073730  0.4458110E-01
 0.000000  0.000012  0.000020  0.000034  0.000047  0.000056  0.000080  0.000093
 0.000105  0.000135  0.000153  0.000177  0.000211  0.000230  0.000259  0.000291
 0.000308  0.000337  0.000357  0.000371  0.000398  0.000417  0.000433  0.000487
 0.000524  0.000570  0.000693  0.000788  0.000939  0.001250  0.001489  0.001985
 0.002691  0.003203  0.004420  0.005345  0.006047  0.007392  0.007911  0.008467
 0.009439  0.010096  0.011052  0.013261  0.014702  0.017279  0.019923  0.021251
 0.022791  0.022081  0.021466  0.019026  0.017743  0.016545  0.015144  0.014892
 0.014606  0.014726  0.014832  0.015026  0.014867  0.014569  0.013622  0.012230
 0.011239  0.009002  0.007732  0.006699  0.004682  0.004096  0.003374  0.002444
 0.002114  0.001691  0.001309  0.001128  0.000871  0.000717  0.000626  0.000488
 0.000409  0.000351  0.000269  0.000237  0.000202  0.000142  0.000118  0.000087
 0.000051  0.000032  0.000000
 4  0.083500  0.5011991E-01
 0.000000  0.000026  0.000046  0.000066  0.000095  0.000127  0.000153  0.000178
 0.000232  0.000264  0.000298  0.000339  0.000391  0.000423  0.000452  0.000483
 0.000503  0.000515  0.000523  0.000529  0.000537  0.000547  0.000559  0.000597
 0.000638  0.000690  0.000766  0.000921  0.001076  0.001259  0.001566  0.001993
 0.002396  0.002834  0.003519  0.004053  0.004508  0.004953  0.005710  0.006380
 0.007171  0.008262  0.010277  0.012263  0.014395  0.017300  0.019604  0.020549
 0.020993  0.020233  0.019148  0.018197  0.017244  0.016093  0.015527  0.015019
 0.014529  0.014123  0.013990  0.013929  0.014003  0.014174  0.014205  0.014127
 0.013443  0.012160  0.010838  0.009366  0.007107  0.005820  0.004734  0.003798
 0.002841  0.002384  0.001997  0.001607  0.001315  0.001128  0.000963  0.000778
 0.000663  0.000576  0.000499  0.000378  0.000326  0.000272  0.000205  0.000143
 0.000099  0.000056  0.000000
```

```
5  0.093260   0.5421200E-01
0.000000  0.000010  0.000019  0.000028  0.000036  0.000046  0.000056  0.000068
0.000080  0.000092  0.000105  0.000119  0.000134  0.000156  0.000180  0.000206
0.000238  0.000277  0.000325  0.000397  0.000496  0.000625  0.000784  0.001001
0.001286  0.001627  0.002134  0.002674  0.003223  0.003766  0.004278  0.004744
0.005203  0.005722  0.006301  0.007053  0.008000  0.009131  0.010393  0.011893
0.012736  0.013177  0.013306  0.013242  0.013139  0.013227  0.013718  0.014581
0.015708  0.016983  0.018264  0.019401  0.020194  0.020291  0.020107  0.019725
0.019182  0.018465  0.017255  0.015556  0.013596  0.011476  0.009378  0.007467
0.005806  0.004439  0.003609  0.002960  0.002490  0.002160  0.001895  0.001683
0.001521  0.001394  0.001277  0.001164  0.001053  0.000935  0.000814  0.000714
0.000621  0.000537  0.000458  0.000375  0.000306  0.000238  0.000188  0.000143
0.000096  0.000047  0.000000
6  0.103030   0.1409742E+00
0.000000  0.000004  0.000008  0.000012  0.000018  0.000023  0.000029  0.000036
0.000044  0.000053  0.000064  0.000077  0.000093  0.000113  0.000137  0.000168
0.000205  0.000248  0.000306  0.000374  0.000459  0.000568  0.000709  0.000889
0.001127  0.001454  0.001897  0.002479  0.003244  0.004206  0.005381  0.006602
0.007636  0.008400  0.008890  0.009218  0.009557  0.010069  0.010859  0.011963
0.013322  0.014741  0.015939  0.016752  0.017102  0.017059  0.016866  0.016708
0.016623  0.016521  0.016257  0.015724  0.014924  0.013961  0.012990  0.012180
0.011665  0.011486  0.011599  0.011887  0.012137  0.012012  0.011337  0.010162
0.008698  0.007159  0.005774  0.004668  0.003809  0.003149  0.002666  0.002303
0.002020  0.001782  0.001591  0.001411  0.001243  0.001091  0.000949  0.000818
0.000699  0.000596  0.000497  0.000409  0.000333  0.000267  0.000208  0.000142
0.000096  0.000049  0.000000
7  0.112790   0.1815646E+00
0.000000  0.000006  0.000013  0.000021  0.000028  0.000036  0.000047  0.000058
0.000071  0.000086  0.000105  0.000128  0.000155  0.000189  0.000231  0.000283
0.000355  0.000449  0.000568  0.000739  0.000970  0.001291  0.001721  0.002366
0.003121  0.004054  0.005125  0.006133  0.007022  0.007742  0.008332  0.008900
0.009556  0.010344  0.011196  0.011933  0.012330  0.012249  0.011757  0.011060
0.010374  0.009907  0.009744  0.009888  0.010326  0.010970  0.011737  0.012581
0.013449  0.014404  0.015517  0.016748  0.017849  0.018505  0.018333  0.017174
0.015282  0.013124  0.011116  0.009494  0.008314  0.007525  0.007027  0.006711
0.006470  0.006204  0.005850  0.005396  0.004796  0.004188  0.003582  0.003018
0.002509  0.002092  0.001722  0.001412  0.001166  0.000960  0.000790  0.000650
0.000530  0.000428  0.000353  0.000282  0.000228  0.000174  0.000136  0.000101
0.000060  0.000030  0.000001
8  0.122560   0.1870000E+00
0.000001  0.000006  0.000013  0.000021  0.000027  0.000036  0.000045  0.000055
0.000067  0.000083  0.000099  0.000118  0.000141  0.000169  0.000203  0.000248
0.000303  0.000372  0.000464  0.000581  0.000743  0.000967  0.001266  0.001782
0.002403  0.003231  0.004277  0.005429  0.006519  0.007379  0.007905  0.008097
0.008161  0.008307  0.008675  0.009321  0.010232  0.011350  0.012757  0.014044
0.015285  0.016490  0.017566  0.018355  0.018697  0.018396  0.017533  0.016473
0.015615  0.015159  0.015221  0.015717  0.016384  0.016713  0.016130  0.014688
0.012696  0.010626  0.008862  0.007511  0.006504  0.005811  0.005328  0.004922
0.004531  0.004124  0.003712  0.003310  0.002868  0.002532  0.002231  0.001972
0.001751  0.001552  0.001377  0.001213  0.001062  0.000929  0.000805  0.000692
0.000591  0.000504  0.000412  0.000339  0.000275  0.000219  0.000168  0.000127
0.000080  0.000039  0.000004
9  0.132320   0.1191757E+00
0.000000  0.000002  0.000004  0.000006  0.000008  0.000011  0.000014  0.000017
0.000021  0.000026  0.000032  0.000040  0.000050  0.000065  0.000083  0.000106
0.000138  0.000189  0.000249  0.000332  0.000438  0.000610  0.000799  0.001043
0.001328  0.001744  0.002166  0.002632  0.003157  0.003852  0.004603  0.005521
0.006713  0.008568  0.010898  0.013770  0.016916  0.019819  0.021071  0.020589
0.019024  0.016935  0.015159  0.014037  0.013350  0.013088  0.013238  0.013710
0.014432  0.015445  0.016416  0.016835  0.016424  0.014966  0.012694  0.010545
0.008722  0.007367  0.006466  0.006092  0.006024  0.006201  0.006586  0.006955
0.007223  0.007288  0.007013  0.006521  0.005858  0.005146  0.004295  0.003625
0.003009  0.002479  0.001945  0.001569  0.001261  0.001006  0.000777  0.000615
0.000494  0.000393  0.000301  0.000241  0.000189  0.000145  0.000110  0.000078
0.000048  0.000025  0.000004
10  0.142090   0.6631271E-01
0.000001  0.000006  0.000012  0.000019  0.000025  0.000032  0.000040  0.000047
0.000055  0.000067  0.000078  0.000091  0.000108  0.000126  0.000148  0.000176
0.000204  0.000241  0.000282  0.000324  0.000383  0.000444  0.000518  0.000632
0.000764  0.000946  0.001228  0.001556  0.002019  0.002610  0.003201  0.003904
0.004624  0.005334  0.006325  0.007502  0.008963  0.011166  0.013162  0.015009
0.016458  0.016951  0.016865  0.016247  0.015322  0.014037  0.012647  0.011482
0.010513  0.010005  0.009906  0.010174  0.010604  0.011045  0.011439  0.011593
0.011630  0.011611  0.011592  0.011570  0.011502  0.011377  0.011173  0.010964
0.010805  0.010682  0.010595  0.010450  0.010034  0.009403  0.008489  0.007248
0.006157  0.005036  0.004053  0.003353  0.002718  0.002226  0.001868  0.001541
0.001304  0.001119  0.000912  0.000775  0.000641  0.000509  0.000400  0.000296
0.000192  0.000101  0.000019
11  0.151860   0.5348957E-01
0.000002  0.000010  0.000021  0.000031  0.000042  0.000053  0.000064  0.000076
```

```
 0.000088  0.000101  0.000114  0.000129  0.000143  0.000161  0.000178  0.000200
 0.000222  0.000252  0.000282  0.000326  0.000369  0.000437  0.000505  0.000617
 0.000729  0.000917  0.001113  0.001428  0.001773  0.002316  0.002913  0.003798
 0.004747  0.006021  0.007269  0.008698  0.009920  0.011061  0.011858  0.012445
 0.012800  0.013007  0.013114  0.013160  0.013170  0.013163  0.013157  0.013175
 0.013239  0.013371  0.013577  0.013840  0.014133  0.014356  0.014462  0.014341
 0.013938  0.013334  0.012458  0.011596  0.010614  0.009839  0.009061  0.008537
 0.008061  0.007777  0.007538  0.007402  0.007267  0.007142  0.006927  0.006674
 0.006255  0.005821  0.005212  0.004670  0.004032  0.003496  0.002934  0.002492
 0.002071  0.001722  0.001410  0.001156  0.000933  0.000732  0.000565  0.000402
 0.000267  0.000134  0.000030
12  0.161620  0.5314855E-01
 0.000001  0.000003  0.000006  0.000009  0.000013  0.000016  0.00001[illegible]  0.000023
 0.000027  0.000031  0.000035  0.000039  0.000044  0.000050  0.000056  0.000064
 0.000074  0.000087  0.000102  0.000126  0.000157  0.000200  0.000268  0.000358
 0.000502  0.000712  0.001010  0.001489  0.002093  0.003017  0.004130  0.005425
 0.006904  0.008118  0.009201  0.009853  0.010219  0.010384  0.010432  0.010420
 0.010327  0.010130  0.009765  0.009322  0.008757  0.008251  0.007844  0.007619
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18 0.220210 0.7130238E-01

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19 0.229980 0.4983377E-01

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20 0.239750 0.5254655E-01

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21 0.249510 0.4529078E-01

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22 0.259280 0.3477027E-01

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23 0.269040 0.2901915E-01

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0.018019	0.016620	0.012684	0.009516	0.008036	0.007867	0.008415	0.008949
0.008883	0.008305	0.007809	0.007867	0.008604	0.009777	0.010736	0.010816
0.010048	0.009107	0.008572	0.008609	0.009042	0.009421	0.009188	0.008092
0.006457	0.004835	0.003564	0.002697	0.002154	0.001841	0.001686	0.001647
0.001699	0.001831	0.002034	0.002299	0.002608	0.002934	0.003240	0.003478
0.003616	0.003625	0.003498	0.003250	0.002904	0.002486	0.002022	0.001531
0.001026	0.000515	0.000124					

Appendix E: Notation

Text	Appendix C	
	DEPTH	Water depth
dd		Two-digit code for day
df		Frequency increment
$d\theta$		Direction increment
$D(f_n, \theta_m)$	DD(N,M)	Directional distribution function at frequency f_n and direction θ_m
FD		Frequency direction
f_n	F(N)	n^{th} frequency of a set of N discrete frequencies
f_p		Peak frequency
$f_{p,FD}$		Frequency at peak of frequency-direction spectrum
$f_{p,IFS}$		Frequency at peak of integrated frequency spectrum
	GPAT	Nine-digit code for pattern of operating gages
hh		Two-digit code for hour
hhmm	IHM	Four-digit code for time of day using hh for hour and mm for minute
H_{mo}		Characteristic wave height
$I(f_n, \theta_j)$		Cumulative distribution function at frequency f_n and direction θ_m
j		Index associated with discrete direction
m	M	Index associated with discrete direction
M	ND	Integer number of discrete directions
mm		Two-digit code for month or minute as dictated by context
n	N	Index associated with discrete frequency
N	NF	Integer number of discrete frequencies
$S(f_n)$	FS(N)	Integrated frequency spectral density at frequency f_n

Text	Appendix C	
$S(\theta_m)$	DS(M)	Integrated direction spectral density at direction θ_m
$S(f_n, \theta_m)$	FDS(N,M)	Frequency-direction spectral density at frequency f_n and direction θ_m
T_p		Spectral peak period
$T_{p,FD}$		Spectral peak period from the frequency at which the frequency-direction spectrum is a maximum
$T_{p,IFS}$		Peak period from the integrated frequency spectrum
yy		Two-digit code for year
yymmdd	IYMD	Six-digit code for date using yy for year, mm for month, and dd for day
$\Delta\theta$		Directional spread parameter
$\Delta\theta_n$		Directional spread parameter of a 180-deg directional distribution at frequency f_n
$\Delta\theta_{FDP}$		Directional spread parameter of the directional distribution at the peak frequency of a frequency-direction spectrum
$\Delta\theta_{IDS}$		Directional spread parameter of integrated direction spectrum
$\Delta\theta_{SW}$		Spectrally weighted directional spread parameter
θ_j		j^{th} direction of a set of M discrete directions
θ_m	D(M)	m^{th} direction of a set of M discrete directions
θ_p		Peak direction
$\theta_{p,n}$		Direction of peak in directional distribution function at frequency f_n
$\theta_{p,FD}$		Direction at peak of frequency-direction spectrum
$\theta_{p,IDS}$		Direction at peak of integrated direction spectrum
$\theta_{p,SW}$		Spectrally weighted peak direction

$\theta_{25\%,n}$		Direction at which cumulative distribution function equals 0.25 at frequency f_n
<u>Text</u>	<u>Appendix C</u>	
$\theta_{50\%,n}$		Direction at which cumulative distribution function equals 0.50 at frequency f_n
$\theta_{75\%,n}$		Direction at which cumulative distribution function equals 0.75 at frequency f_n